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Title: Exploring Intuitive Use

Abstract approved:

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Kenneth H. Funk

The term "Intuitive use" has become a common phrase to describe interfaces and products, however it is rarely defined. Research regarding intuitive use is in its infancy, beginning primarily in 2003. With the development of new terms in Human Factors and Human-Computer Interaction, it is important for Designers and Users to clearly understand their definitions and how those definitions impact design requirements. The three research questions were as follows. (1) Is there a significant gap between Users' and Designers' definitions of intuitive use? (2) Do their definitions agree with the literature definition? (3) Can they distinguish the attributes separating intuitive use from usability?

A survey was conducted of 134 participants (41 Users and 93 Designers). The results showed no significant difference between Users' and Designers' perceptions of the attributes that comprise intuitive use (*Subconscious use, Effective results, Prior Knowledge, Low mental effort, and Satisfying results*). Users and Designers strongly agreed (between 4-5 on a 5 point Likert scale) with the literature for the attributes *Effective Results, Prior Knowledge,* and *Low mental effort.* Users and Designers had a moderate level of agreement (between 3-4 on a 5 point Likert scale) for the attributes *Subconscious* and *Satisfying results*. Lastly, Users and Designers had a strong level of agreement for the attribute *Cost ($),* inferring they do not associate this attribute with intuitive use. Users and Designer had a moderate level of agreement for the attributes *Users' Physical Effort* and *Time,* inferring they do not associate these attributes with intuitive use. The results were discussed and recommendations were given for researchers and Designers.

Exploring Intuitive Use

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APPROVED:

Major Professor, representing Industrial Engineering

Head of the School of Mechanical, Industrial and Manufacturing Engineering

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Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Tylee Cairns, Author

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1 Introduction

1.1 Background

The term “intuitive use” has become a common phrase to describe interfaces and products, however it is rarely defined. It seems everyone wants an “intuitive interface” yet no one knows exactly what that means. With the development of new terms in Human Factors (HF) and Human-Computer Interaction (HCI), it is important for Designers and Users to clearly understand their definitions and how those definitions impact design requirements. Eric Von Hippel from the MIT Business School said, “70% to 80% of new product development that fails does so not for lack of advanced technology, but because of a failure to understand users’ needs” (von Hippel, 2007, p. 27). If someone asked you to design an intuitive interface, what would you do?

A review of the literature in Chapter 2 showed a variety of fields that have explored intuition, including education (Swaak & de Jong, 1996) and psychology (Kahneman, 2002; Pretz & Totz, 2007). However, research regarding intuitive use in HF and HCI fields is in its infancy, beginning primarily in 2003. Alethea Blackler (2003a) was among the first to specifically explore this term. Blacker conducted a literature review to understand the meanings and applications of intuitive use. Blackler experimentally proved prior knowledge of features or functions allows participants to use those features or functions intuitively. Later, the Intuitive User of User Interfaces (IUUI) group started in 2005 at Technische Universität Berlin (Blackler & Hurtienne, 2007). An IUUI group member, Mohs (2006) derived a definition of intuitive use through a literature review, survey of users and consultation of HCI experts in Germany. Since 2006, the definition has been refined several times by the IUUI. The most recent definition of intuitive use was presented by Hurtienne (2011, p. 15):

> *“Intuitive use is defined as the extent to which a product can be used by subconsciously applying prior knowledge, resulting in an effective and satisfying interaction using a minimum of cognitive resources”*

Recently, frameworks, design methodologies and requirements for intuitive use from image schemata have been pursued by Hurtienne (2011), Blacker (2006) and Loeffler (2013). While this group of researchers seems to agree on a definition of intuitive use, others have differing views. Some said intuitive use is immediate usability where no prior knowledge or learning is required (Bullinger, Ziegler, & Bauer, 2002) while others claimed it is synonymous with the word “familiar” (Raskin, 1994). Since Mohs’ survey in 2006, the agreement of the literature definition has not been verified.

Additionally, the agreement with the changes made to the definition since the original survey is unknown.

1.2 Motivation

Assessing the level of agreement among groups will speak to the stability and validity of the foundation in which intuitive use is currently built. The infancy of the field and the uncertainty of a widely accepted definition are additional motivators to investigate the meaning of intuitive use. Although intuition varies among individuals (Loeffler et al., 2013, p. 1) it is beneficial to seek trends about its meaning. With continued exploration "it is possible to further develop this concept to create guidelines for the design of intuitively usable systems and devices" (Pretz & Totz, 2007).

1.3 Objectives

The primary purpose of this research was to verify Users' and Designers' definitions of intuitive use with each other and with the literature. Also, the research was intended to assess Users' and Designers' abilities to distinguish usability from intuitive use. Lastly, the research sought to identify guidelines and recommendations for researchers and Designers. Returning to the original problem, if someone asked you to design an intuitive interface, what would you do? There is a need to verify and explore additional information from both Users and Designers. The goal of this research was to answer the following questions:

1. Is there a significant gap between Users' and Designers' definitions of intuitive use?
2. Do Users' and Designers' definitions of intuitive use agree with the literature definition?
3. Can Users and Designers distinguish the attributes separating intuitive use from usability?

1.4 Methodology

To answer the questions above, a survey was developed in Qualtrics to collect the views of Users and Designers. The survey began with an open-ended response block to gather participants' unbiased definitions. Then, each research question was addressed in the survey with its own block. Blocks contained statements using attributes of intuitive use presented in the literature. The survey was web-based and participants were recruited using email, social media, bulletin boards, etc. The following chapters of this thesis detail the study's literature review, methodology, results, discussion, and conclusions.

2 Literature Review

2.1 Introduction

The definition of intuition is not often analyzed among Human Factors and Usability experts. When explained it is described as “knowing without being able to explain how we know” (Vaughan, 1979, p. 46) or thought of as a “hunch” or “gut feeling” (Pretz & Totz, 2007). In fact, many papers fail to define the term despite its pivotal importance (Fujii et al., 2011; Sugawara & Maruta, 2009; Tanyag, Angco, & Atienza, 2009). A review of the literature displays a variety of fields that have explored intuition, including education (Swaak & de Jong, 1996), psychology (Kahneman, 2002; Pretz & Totz, 2007), human-computer interaction (Bullinger et al., 2002), computer science (Bödi & Kaulich, 1992; Hadar & Leron, 2008), design and linguistics (Hurtienne & Israel, 2007).

However, in 1992, Richard A. Bödi was among the first to describe the term “intuitive” with regard to interfaces (Bödi & Kaulich, 1992). Bödi ascribes the term Intuitive User Interfaces (IUI’s) to graphical-oriented user interfaces opposed to command line interfaces. IUI’s are operated using a mouse or other pointing device and the keyboard is used only if necessary. According to Bödi, “user interfaces which may be called intuitive, must:

- Allow quick and easy handling for novices just as for experienced users
- Make it possible to cancel or break off activated functions and undo decisions easily
- Provide a well-structured and distinct layout based on graphics.” (Bödi & Kaulich, 1992, p. 69).

The literature on intuition within the field of HCI begins slowly in the 1990’s and gains much of its momentum in the 2000’s and into the present day. Findings include terminology, attributes, definitions, its comparison with usability, frameworks, experimental findings and design methodologies.

2.2 Terminology

In order to be clear about the term’s meaning and proper use, similar terminologies are explained. The literature uses several words surrounding the idea of intuition including instinct, insight, intuitive, intuitiveness (Sundar, Bellur, Oh, Xu, & Jia, 2014), intuitivity (Jörn Hurtienne & Israel, 2007; A. Naumann et al., 2007), intuitive use, intuitive use of products, intuitive interaction, intuitive user interface, intuitive knowledge, intuitive human-computer interaction, and intuitive judgment.

First, the etymology is discussed to help bring clarity. Etymologically, "Intuition literally means - seeing through the eye, visual perception […] - the apprehension or discerning of a thing actually present to the eye; and it is distinguished, on the one hand, from the revival of that thing in memory…" (Davidson, 1882; Turner, 2008). Therefore, intuition is speaking about a person's ability to distinguish visual perceptions through the revival of memory.

Next, intuition should not be confused with instinct or insight. Instinct "pertains merely to hardwired, autonomous reflex actions, for example a 'knee-jerk', or the behaviour patterns of certain animals (such as the homing instinct in birds). Insight, on the other hand, is a sudden and unexpected solution to a problem, arrived at after an impasse has been reached and an incubation period has elapsed" (Hodgkinson, Sadler-Smith, Burke, Claxton, & Sparrow, 2009, p. 279). Thus, instinct is not equivalent to intuition because intuition is not hardwired and is based on past experience (Blackler et al., 2003a). Likewise, insight is not equivalent to intuition because of the incubation period for an insight to occur and it does not align with intuition's speed (Kahneman, 2002).

Moreover, only human information processes can be labeled as "intuitive". Following the etymology, intuition is not a characteristic of an object, rather the relation between a person and an artifact. An object cannot intuit, therefore "terms like 'intuitive interface' or 'intuitive device'…should thus be avoided. 'Intuitive use' can only be used in the context of task, user, environment and technical system. More precisely, intuitive use can only be attributed to the human–machine interaction" (Israel et al., 2009, p. 351).

This thesis focuses on defining intuition within the context of human-machine interaction and will therefore, use the terms "intuitive interaction" or "intuitive use". However, the literature review section is true to the authors' original language and other terms are present.

2.3 Attributes of Intuitive Use

While some pieces of literature do not explicitly state a definition for intuitive use, many describe its attributes. Thus, it is fruitful to explore the attributes given to intuition to help understand its definition.

Swaak approaches intuition from educational evaluation and environmental knowledge. Swaak describes qualities of knowledge; one of them is captured under the term intuitive. Intuition is defined as follows: "formulating or solving a problem through a sudden illumination based on global perception of a phenomenon…it originates from widely varied experience of that phenomenon over a long time" (Swaak & de Jong, 1996, p. 344). In summary, Swaak describes intuitive knowledge as (1) low verbalizability, (2) rich situations, and (3) quick perception. Thus, intuition is manifested into quick perception of meaningful situations (Swaak & de Jong, 1996). Following Swaak, Bullinger (2002) agrees that intuitive use is based on prior experience, however only associates it with natural modes of expression and familiarity.

Blackler (2003a) conducted an extensive literature review concluding intuition "is a cognitive process that utilises knowledge gained through prior experience…involves utilising knowledge gained through other products or experience(s)" (Blackler et al., 2003a, p. 1). This means that an intuitive use occurs with previously encountered features. Blackler identifies three factors of product features, (1) location of the feature on the product, (2) appearance of the feature, and (3) function of the feature. Blackler's location factor and Bödi's well-structured layout attribute, from 1992, show agreement.

In order to grasp the level of agreement within attributes, a matrix was constructed. The matrix, available in Appendix A, assembles the attributes associated with intuition. It comprises 23 papers from a literature search of the fields discussed in 2.1. Each piece of literature was reviewed for attributes associated with intuition based on the authors' own statements as well as statements referenced from other sources in which they agreed. For example, the following statement "intuition draws on our inborn ability to synthesize information quickly and effectively" (Dane & Pratt, 2007, p. 33) resulted in association with the attribute "Fast/rapid/quick/immediate" and "Effective interaction (correctness)" in the matrix. Likewise, "appearance of features seems to be the variable that most affects time spent on a task and intuitive uses" (Blackler, Popovic, & Mahar, 2007, p. 4) results in association with the attribute "Appearance".

Table 1 provides a summary of the attributes compiled in the matrix. The numbers shown in the table represent the percentage of papers out of 23 that associate a given attribute with intuition. Therefore, an attribute with a higher percentage represents a higher level of association between intuition and the given attribute.

Table 1 Percentage of papers out of 23 that associate a given attribute with intuition

Attributes	Percentage (%)
Subconscious Process	73.9%
Cognitive Process	73.9%
Knowledge through prior experience	69.6%
Fast/rapid/quick/immediate	69.6%
Automatic/natural	56.5%
Effective interaction (correctness)	43.5%
Familiar	34.8%
Transferring knowledge of features	30.4%
Rule-based (SRK) - Skill Based	26.1%
Location	26.1%
Non-verbalizable	26.1%
Dual Process Theory - S1	26.1%
Appearance	21.7%
Technical System	17.4%
Function	17.4%
Effortless	17.4%
Easy-to-use	17.4%

Table 1 shows that the top five attributes associated with intuition are: subconscious process, cognitive process, knowledge gained through prior experience, fast/rapid/quick/immediate, and automatic/natural. Equally important are the attributes that received low association with intuition. The five attributes that showed the least association with intuition are: appearance, technical system, function, effortless and easy-to-use.

The HCI community views intuition in a functional and operational way. Turner simply states, “Intuitive systems are usable systems” (Turner, 2008, p. 1). Similarly, authors state that intuitive interaction is immediate usability where no prior knowledge or learning is required (Bullinger et al., 2002) and is largely dependent on familiarity of the user interface elements (Bullinger et al., 2002; Raskin, 1994). Other attributes include building on existing knowledge, or transferring knowledge from other domains (Turner, 2008). On the contrary, psychologists (e.g., Kahneman, 2002), and managers (Dane & Pratt, 2007; Hodgkinson et al., 2009) approach intuition from a different perspective, for example, the association of intuition with dual-process theory – S1. Dual process theory states there are two reasoning processes (Stanovich & West, 2000). Stanovich and West generically label these processes System 1 (S1) and System 2 (S2). System 1 relates to quick, automatic, fast, and intuitive cognition, hence the correlation of S1 with intuition in the literature. In conclusion, the matrix shows the HCI and the design community taking a more functional approach (relating intuition to technical systems, location, appearance, and function) and the psychologist and managers taking a more theoretical approach (dual-process theory). Despite the varying approaches among differing fields, there is overlap and agreement with the attributes associated with intuition. This overlap is clearly expressed by the higher percentage attributes in Table 1.

2.4 Definitions of Intuitive Use

Definitions of intuition within the fields of psychology, philosophy and management have a long and rich history. For example, Davidson (1882) discusses its definition in the late 19th century and Dane (2007) culls 17 definitions between 1933 and 2004. However, the history of definitions pertaining to HCI and design fields is scarce in comparison. The first explicit, formal definition discovered in this literature review is by the Intuitive Use of User Interfaces (IUUI) research group. The IUUI group started in late 2005 at Technische Universität Berlin (Blackler & Hurtienne, 2007). An IUUI group member, Mohs (2006) derived a definition through literature review and a user survey. Mohs' definition of intuitive use is as follows:

> *"A technical system is intuitively usable if the users' unconscious application of prior knowledge leads to effective interaction" (Mohs, Hurtienne, Israel, et al., 2006, p. 130).*

The survey was conducted among "naïve users". Without any instruction in advance, the users were asked for associations with intuitiveness and then indicated their level of agreement on 31 statements. The author does not state how these statements were generated (Mohs, Hurtienne, Scholz, et al., 2006). A total of 22 people with varying education level and occupation responded. "The naive user's idea of 'intuitive operation' is consistent with the adopted definition of intuitiveness in terms of unconsciousness, non-reflection and the reference to prior knowledge." (Mohs, Hurtienne, Scholz, et al., 2006, p. 5).

Shortly following Mohs' is a definition by Blackler (2007). Blackler's definition of intuitive use is as follows:

> *"Intuitive use of products involves utilising knowledge gained through other experience(s). Therefore, products that people use intuitively are those with features they have encountered before. Intuitive interaction is fast and generally non-conscious, so people may be unable to explain how they made decisions during intuitive interaction" (Blackler et al., 2007, p. 5).*

Both Mohs' and Blackler's definitions agree with frequently cited attributes in Table 1, knowledge through prior experience, and subconscious process. Some details differ, such as Mohs' assertion that intuitive use leads to effective interaction. Blackler does not comment on the outcome from an intuitive use in her definition. However, Blackler's definition comments on the speed of an intuitive use, fast, and that people may not be able to explain their decisions (non-verbalizable). The attributes fast, and non-verbalizable appear in Table 1, scoring 69.6% and 26.1%, respectively.

Following Mohs' and Blackler's definitions in 2006, refinements have been made as well as others proposed. Table 2 is a synthesis of intuitive use definitions presented in the literature, starting with Mohs' original definition, V1.0.

Table 2 Intuitive Use Definitions Presented in the Literature

Source	Definition
(Mohs, Hurtienne, Israel, et al., 2006, p. 130)	"A technical system is intuitively usable if the users' unconscious application of prior knowledge leads to effective interaction" V1.0
(Blackler et al., 2007, p. 5)	"Intuitive use of products involves utilising knowledge gained through other experience(s). Therefore, products that people use intuitively are those with features they have encountered before. Intuitive interaction is fast and generally non-conscious, so people may be unable to explain how they made decisions during intuitive interaction"
(Hußlein et al., 2007, p. 26)	"intuitive use is given when users can apply their prior knowledge using a minimum of cognitive resources to effectively solving their task" V1.0.1
(A. Naumann et al., 2007, p. 129)	"A technical system is, in the context of a certain task, intuitively usable while the particular user is able to interact effectively, not-consciously using previous knowledge" V1.1
(Blackler, Popovic, & Mahar, 2010, pp. 74–75)	"Intuition is a type of cognitive processing that utilises knowledge gained through prior experience (stored experiential knowledge). It is a process that is often fast and is non-conscious, or at least not recallable or verbalisable"
(Hurtienne, 2011, p. 15)	"Intuitive use is defined as the extent to which a product can be used by subconsciously applying prior knowledge, resulting in an effective and satisfying interaction using a minimum of cognitive resources"
(Britton, Setchi, & Marsh, 2013, p. 188)	"an interaction in which proficiency in the interface's key functions is gained with minimal cognitive processing power and is therefore within the smallest possible time frame. An intuitive interface should consist of a number of intuitive applications allowing multiple intuitive interactions to take place when performing a varied array of tasks"

Hußlein (2007) revised Mohs' V1.0 definition, to V1.0.1. The definition was changed to a more operational definition and sought to reduce the vagueness of the term "subconscious" (Hurtienne, 2011). Other concepts are unchanged from V1.0 to V1.0.1. Meanwhile, the phrase "minimum of cognitive resources" emphasizes the essence of intuitive use.

Naumann (2007), a member of the IUUI research group, worked on refining the original definition (V1.0) proposed by Mohs. In the refined definition, Naumann describes intuitive use "in the context of a certain task". Tasks or activities have a hierarchical structure and are divided into goals and sub-goals. The refinement of the definition clarifies that intuitive use does not pertain to the task as a whole, but rather the sub-goals of the task. Sub-tasks are subconscious and regulated by trigger mechanisms (e.g., 'Traffic light red – brake') (A. Naumann et al., 2007). Another addition to V1.1 is the phrase, "particular user". Each user has differing prior knowledge and experience; therefore, what is an intuitive use for one user may not be for another. The use of the term "not-conscious" is added after being removed from V1.0 to V1.0.1 due to a concern of its ambiguity. The notion of "effective" remains present in both V1.0 and V1.1 of the definitions. The emphasis here is the consequence of an intuitive use, that it "leads the user to adequate, exact and complete interaction results" (A. Naumann et al., 2007, p. 134).

Blackler slightly refined her definition three years later in 2010. It remains largely unchanged, mostly clarifying and summarizing for conciseness. Blackler inserts "cognitive process" to the definition clarifying much of what is said in Section 2.2. "Intuitive" is a characteristic of an interaction with a human-machine interface and is not an attribute of a product or interface alone (as discussed in Section 2.2). Lastly, Blackler replaces "unable to explain how they made decisions during intuitive interaction" with "or at least not recallable or verbalisable". This clarifies "unable to explain", which can both mean the user "forgot" or, because of its subconscious nature it cannot be made verbal.

Hurtienne (2011), a member of the IUUI research group, considered Blacker's definitions, additional literature review, and the previous work of the IUUI research group to propose his definition of intuitive use. Many of the core concepts are the same (subconscious, prior knowledge, minimum of cognitive resources, effective interaction), however important additions were made. First was the subtle addition of the phrase "the extent to". Hurtienne states, "people use the term 'intuitive use' in describing whole interaction episodes that aggregate across several operations" (Hurtienne, 2011, p. 15), and therefore calls for a more continuous description instead of one that classifies intuitive use as discrete: yes or no. Second, "satisfying interaction" was added to the definition. An implication of intuitive use is a positive subjective evaluation by the user. Thus, an intuitive use is one that is satisfying for the user. Hurtienne proposed satisfaction is an important consequence of intuitive use and reflects it in his definition.

Britton (2013) outlined a definition of intuitive use for the purpose of a study with multifunctional mobile interfaces. Britton drew on the work of Blackler, Hurtienne, and Mohs. Although the intent here was not to make dramatic improvements upon the current definitions, Britton's interpretation adds operational value. The definition includes the phrase "interface's key functions" which provides direction and perhaps comfort to designers. The interface may have many functions, but the key features are those that require consideration for intuitive use. This suggests a subset of functions will be primary candidates for intuitive use. This agrees with Naumann's notion that intuitive use will apply to sub-goals and not the high-level task. There is continued agreement with Hußlein and Hurtienne regarding a minimization of cognitive resources.

The collection of definitions in Table 2 shows the evolution and refinement of the concept of intuitive use. Many of the definitions contain the attributes that are seen frequently in literature, as shown previously in Table 1. Important additions to the definition since Mohs' in 2006 include:

- Non-verbalizability (Blackler et al., 2010)
- Minimization of cognitive resources (Hußlein et al., 2007)
- Applicability to sub-goals rather than overall tasks (A. Naumann et al., 2007)
- Intuitive use as user-specific (A. Naumann et al., 2007)
- Intuitive use as continuous, not yes or no (Hurtienne, 2011)
- Satisfaction (Hurtienne, 2011)

A definition for intuitive use is of paramount importance to the HCI community because it is the foundation on which future research may build upon.

2.5 Usability vs. Intuitive Use

The previous section shows the addition of efficiency and satisfaction throughout the evolution of intuitive use definitions. Because efficiency and satisfaction are indicators of usability, one may ask the question, "What is the difference between usability and intuitive interaction? Are they referring to the same thing?" The literature has conflicting views regarding this topic. Some authors describe "intuitiveness" as usability and ease of use (Dee & Allen, 2006). Turner simply states, "Intuitive systems are usable systems" (Turner, 2008, p. 1). Similarly, authors state that intuitive interaction is immediate usability where no prior knowledge or learning is required (Bullinger et al., 2002) and is largely dependent on familiarity of the user interface elements (Bullinger et al., 2002; Raskin, 1994). It is unknown if the authors' association of intuitive use and usability is well-thought-out or the terms have been arbitrarily bundled. However, Hurtienne specifically addresses this point.

Hurtienne's comparison begins with presenting the definitions of both concepts.

"Usability is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1998).

"Intuitive use is defined as the extent to which a product can be used by subconsciously applying prior knowledge, resulting in an effective and satisfying interaction using a minimum of cognitive resources" (Hurtienne, 2011, p. 15).

The definitions contain similarities regarding specified context of use involving tasks and users and the degree of fit between the user and technology. The ISO definition of usability contains three criteria (1) effectiveness, (2) efficiency, and (3) satisfaction. Table 3 shows the relevance of usability criteria with design for intuitive use (Hurtienne, 2011).

Table 3 Usability Measures and their Relevance to Design for Intuitive Use. Adapted from "Image Schemas and Design for Intuitive Use" by J. Hurtienne, 2011 (Diss). Copyright 2011. Adapted with permission.

Usability measures (ISO 9241-11)	Indicators	Relevance for Design for Intuitive Use
Effectiveness (the accuracy and completeness with which users achieve certain goals)	error rates	Yes (effective interaction is part of the definition of intuitive use)
	quality of goal achievement	
	proportion of users achieving goal	
Efficiency (the users' comfort with and positive attitudes towards the use of the system)	users' mental effort	Yes (indicators point to subconscious use of prior knowledge)
	number of references to help and documentation	
	learning time	
	users' physical effort	No (no direct correlation with intuitive use according to the above definition)
	task completion time	
	cost	
Satisfaction (the users' comfort with and positive attitudes towards the use of the system)	attitudes	Yes (users should be satisfied with using technology)
	preferences	
	subjective efficiency and efficiency	
	experienced stress and strain	

Parts of the usability criteria agree with intuitive use, therefore intuitive use is a sub-concept of usability. Effectiveness and satisfaction are part of both definitions and therefore agree. However, there is partial agreement for the efficiency criterion. *Users' mental effort* and *number of references to help and documentation* are indicative of mental workload and are applicable indicators, and *learning time* may also be of interest for design. Indicators not correlated with intuitive use are *users' physical effort, task completion time, and cost.* Not correlated means an equal likelihood for the indicator to enhance, decrease, or not affect intuitive use (Hurtienne, 2011). Physical effort is not correlated to intuitive use because a high or low level of physical effort will not dictate the level of mental effort. For example, imagine a software program with a step-by-step wizard. The wizard may result in a reduction of mental effort, but increases physical effort (number of mouse clicks). Hurtienne does not explicitly state the non-correlation between *task completion time* and *cost*, but does state, "Intuitive interaction is about subconscious processing and mental effort" (Hurtienne, 2011, p. 25).

In conclusion, Hurtienne's work comparing usability and intuitive use is important to distinguish for design. Intuitive use is a sub-concept of usability. "Thus, design for intuitive use enhances the single aspect of mental effort at the possible cost of other efficiency measures" (Hurtienne, 2011, p. 25). It is important for designers to use the two different concepts correctly and consciously.

2.6 Frameworks for Intuitive Use

This section describes the frameworks developed to explain intuitive use. Some frameworks are developed before formal definitions that appear in the HCI literature. Others are developed in tandem with definitions. Table 4 presents frameworks from the HCI field.

Table 4 Intuitive Use Frameworks

Source	Framework
(Bullinger et al., 2002)	Communication Bandwidth
(Wensveen, Djajadiningrat, & Overbeeke, 2004)	Couple action and function through feedback and feedforward
(Blackler et al., 2006)	Continuum of Intuitive Interaction
(Hurtienne & Blessing, 2007)	Continuum of Knowledge

Bullinger et al. (2002) describe the communication bandwidth, Figure 1, a visual representation of interfaces of different communication channels.

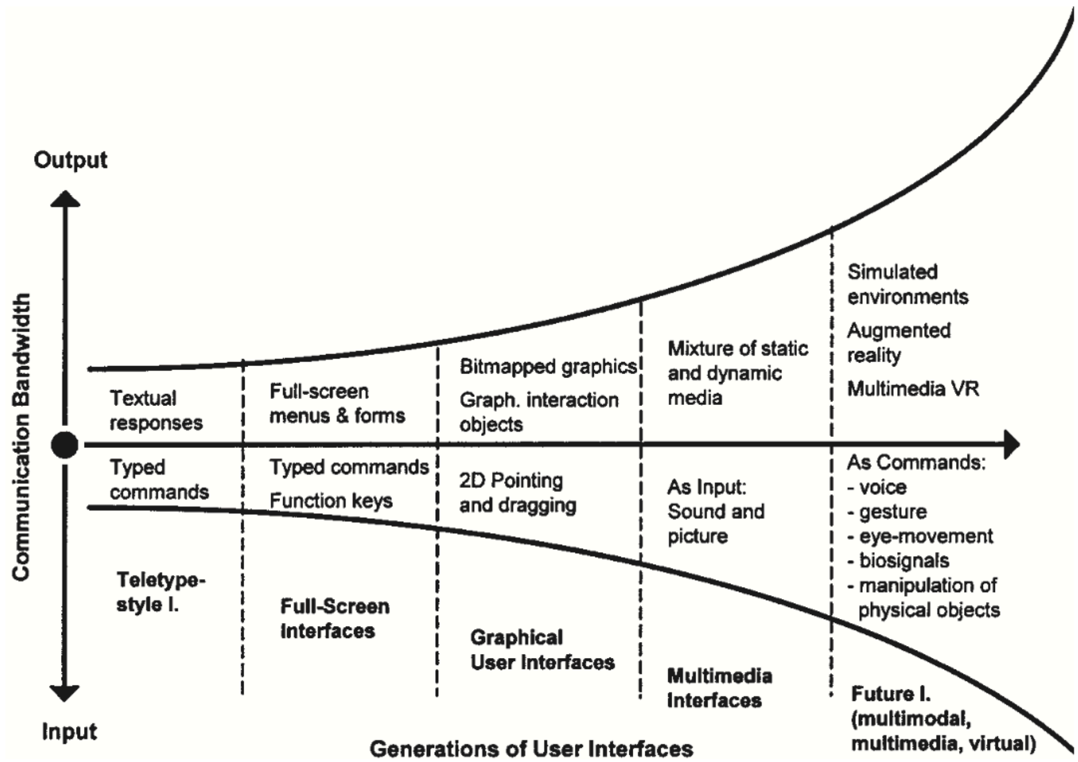


Figure 1 - Broadening of the communication channel between user and system over different generations of user interfaces. Adapted from "Intuitive Human–Computer Interaction—Toward a User-Friendly Information Society" by Bullinger et al., 2002. Copyright 1997.

Communication bandwidth is on the Y-axis; positive Y-values are interface outputs and negative Y-values are the interface inputs. The X-axis represents generations of user interfaces. Moving in the positive x-direction is teletype-style 1, full-screen interfaces, graphical user interfaces, multimedia interfaces, and future 1 (multimodal, multimedia, virtual) interfaces. As the generations of user interfaces progress (from teletype-style 1 to future 1) the communication bandwidth increases. There are more communication channels for the user to input information and more channels for the user to receive information from the interface. For example, teletype-style consists of simply text input and output, an example of low bandwidth. Multimedia interfaces add the ability for sound and picture as inputs and the user receives a mixture of static and dynamic media, an example of greater bandwidth.

Bullinger relates intuitive use with humans' communication channels. "The developments driving the transition to new generations of user interfaces and the resulting broadening of the communication channel have the potential of providing interaction techniques that are more adapted to the human's natural means of expression, and thus more intuitive" (Bullinger et al., 2002, p. 4). According to Bullinger's framework, increasing the communication channel bandwidth will increase intuitive use.

Wensveen (2004) offers a framework to operationalize intuitive use. This framework links action with functional information. Action refers to an input performed by a user and functional information encompasses augmented and inherent feedback to the user. The user's action and functional information is linked through six aspects of natural coupling (1) time, (2) location, (3) direction, (4) dynamics, (5) modality and (6) expression. For a full description of each see Wensveen et al., (2004). Wensveen suggests unifying these six aspects between action and functional information will result in an intuitive interaction. "The idea is that if a direct coupling between action and functional information is broken, because of technological, ergonomic, financial or aesthetic limitations, new couplings should be established in the design" (Wensveen et al., 2004, p. 182). Wensveen provides guidance for the design for intuitive use through unifying action and information. Thus, Wensveen's framework may be used to verify all couplings are provided to the user resulting in intuitive use.

Blackler et al. (2006) presents a framework called the Continuum of Intuitive Interaction, shown in Figure 2. The framework was developed using three main principles, (1) use familiar features from the same domain, (2) transfer familiar things from other domains, and (3) use redundancy and internal consistency. The Continuum of Intuitive Interaction relates terms and theories to levels of intuitive interaction complexity. "It is suggested that as the newness or unfamiliarity of a product increases, so too does the complexity of the designing required to make the interface intuitive to use" (Blackler et al., 2006, p. 5).

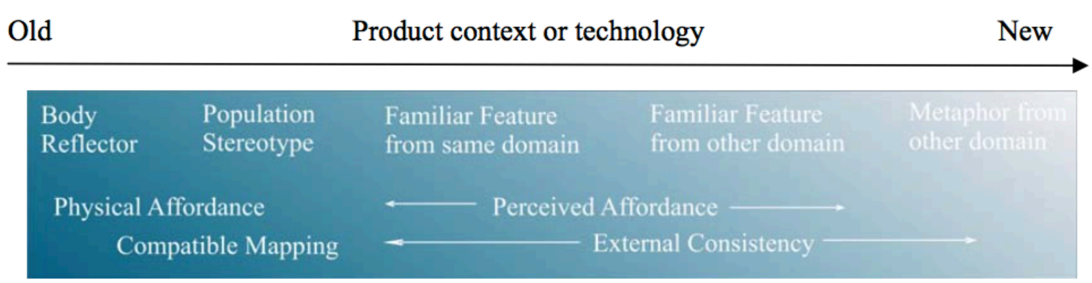


Figure 2 - The intuitive interaction continuum including positions of other interaction theories. Adapted from "Towards a Design Methodology for Applying Intuitive Interaction" by Blackler et al., 2006. Copyright 2006.

On the left of the continuum lies the simplest form of intuitive interaction and on the right of the continuum lies the most complex form of intuitive interaction. Along this continuum are theories and terms. For example, the left most term is body reflector. Body reflectors are embodied knowledge that is learned very early in one's life. Body reflectors reflect or mirror the body. Examples include headsets, glasses, shoes and gloves (Blackler et al., 2006). Thus, designs that represent body reflectors are a simple form of intuitive interaction and have a low design complexity. The rightmost term is "Metaphor from other domain". This is the most complex term and "involves retrieval of useful analogies from memory and mapping of the elements of a known situation" (Blackler et al., 2006, p. 7). Therefore, this is the most complex intuitive interaction and most complex for design. For a description of all seven terms see Blackler et al. (2006). Blackler's framework is a tool for designers to facilitate the design of product features that are intuitive to use.

The definitions presented in Section 2.4 contain the phrase "prior knowledge". Hurtienne & Blessings (2007) provides a framework to describe the different sources of prior knowledge called, The Continuum of Knowledge. The continuum contains four levels of knowledge, (1) innate, (2) sensorimotor, (3) cultural, and (4) expert. The innate knowledge refers to "knowledge that is 'acquired' through the activation of genes or during the prenatal stage of development […] reflexes or instinctive behaviour" (Hurtienne & Blessing, 2007, p. 2). Sensorimotor knowledge refers to early childhood development. This includes recognition of faces, gravitation and image schemas. Next, is cultural knowledge, that is, knowledge specific to the culture an individual lives in. Examples include values, communication styles or usual means of transportation. The highest level of knowledge is expert. This is specialist knowledge usually obtained through one's profession. Spanning the upper three levels is tool knowledge. Tool knowledge refers to specific knowledge of tools that may be found in each level, for example, knowledge of cell phones in the cultural level or knowledge of complex software like electronic medical records for physicians in the expertise level.

Hurtienne states frequent encoding and retrieval of knowledge leads to its application without user awareness. Thus, the innate level is more likely to be applied subconsciously than the expertise level. However, regardless of the knowledge level or frequency of encoding and retrieval, knowledge applied subconsciously may be representative of intuitive use. This framework provides a way for designers to characterize the prior knowledge of users. In doing so, designers can strive to lower the degree of specialized knowledge to access the greatest number of potential users.

The frameworks in this section construct an understanding for intuitive use. Each framework is unique and offers designers a different perspective to approach intuitive use. Bullinger suggests an increase in communication channels between the system and the user to promote intuitive use. Wensveen suggests six aspects of natural coupling (1) time, (2) location, (3) direction, (4) dynamics, (5) modality and (6) expression between users' actions and functional information. Maintaining all six aspects will promote intuitive use. Blackler and Hurtienne both present continuums. Blackler describes levels of intuitive interaction complexity and relates terms and theories with simple and complex design. Hurtienne describes sources of prior knowledge and classifies prior knowledge into four levels. These frameworks are foundational to future research.

2.7 Experimental Findings

Blackler conducted several experiments to test the validity of her theoretical findings. The first experiment focused on prior knowledge. "The experiment objectives were to establish if relevant past experience of product features increased the speed and/or ease with which people could use those features, and to establish if interface knowledge was transferred from known products to new ones" (Blackler et al., 2003a, p. 4). Product features were characterized by three factors, (1) location of the feature on the product, (2) appearance of the feature (e.g. structure, shape, color, labeling) and (3) function of the feature, how it works (Blackler et al., 2003a). Blackler's study had participants perform a series of tasks using a digital camera. Participants' speed and type of interaction were classified as *intuitive*, *quick comment*, *trial & error*, *with working*, or *using manual*, were recorded. A coder judged an intuitive interaction as "fast decision with no evident reasoning." Afterward, participants filled out a technology familiarity questionnaire. The questionnaire asked whether and how often participants used certain products. The questionnaire was meant to assess their depth of knowledge with technology. Blackler concluded relevant past experience is transferable between products. Moreover, a technology familiarity score is deemed more indicative of intuitive use than level of expertise. Follow up experiments validated both findings (Blackler, Popovic, & Mahar, 2003b; Blackler et al., 2007).

Mentioned in the previous experiment are characteristics of product features, (1) location of the feature on the product, (2) appearance of the feature (e.g. structure, shape, color, labeling) and (3) function of the feature, how it works. To find the most important characteristic, four different interface configurations were tested on a universal remote control; *default*, *location*, *appearance*, and *location-appearance*. Results showed appearance had the greatest impact of time on task and intuitive use (Blackler et al., 2003b, 2007). Additional publications on the same experiment concluded "intuitive interaction does depend on past experience with similar features, and it is affected by age." (Blackler et al., 2010, p. 85). The link between age and intuitive interaction requires further work and is not fully understood. Interestingly, age did not appear as an attribute of intuitive interaction in Table 1.

Hurtienne tested a theory from cognitive linguistics called image schema theory. Image schemata are abstract representations of patterns that structure the way humans understand the world. For example, a *container* schema is characterized by an inside, an outside, and a boundary between. Examples include cars, houses, boxes, and cups (Hurtienne & Blessing, 2007). For more information about image schema theory see Hurtienne & Blessing (2007) and Johnson (1987). The question is: can designers build better products (in terms of mental efficiency and satisfaction) when image schema theory is applied to user interface design. Their experiment tested the following image schemata: *more is up, good is up, virtue is up, left-right, and right-left*. There are many other image schemata than were tested. However, initial results "…concluded that image schema theory has very good prospects to provide a design language and guidelines for designing user interfaces that are intuitive to use" (Hurtienne & Blessing, 2007, p. 11). Additional studies were conducted with image schema theory and tangible user interfaces further supporting Hurtienne's claim (Hurtienne & Israel, 2007; Langdon, Clarkson, & Robinson, 2008, pp. 107–116). Another study states, "Applying the theory leads to more intuitive user interfaces that preserve mental capacity for the task at hand, reduce the need for training and are applicable for a wide range of users" (Langdon et al., 2008, p. 116). Finally, Hurtienne's dissertation concludes that interfaces that conform to image schema theory are more effective, mentally efficient, and satisfying. The use of this theory is particularly good for translating requirements into design solutions. The reliability of this method scores high to medium agreement among designers using the image schema vocabulary (Hurtienne, 2011).

Other authors have published findings for "intuitive interfaces" without formally defining the term. The findings are still of interest. Winkler compares key-based versus motion-based interfaces on mobile devices for a car-racing game and virtual map navigation. A key-based interface requires the pressing of keys to control the application. A motion-based interface requires the movement of the mobile device to control the application. Participants were asked to rate the interfaces on a scale from 0 to 10 for intuitiveness. "The results show that the motion-based interfaces are well appreciated for their intuitiveness and perform equally well when compared with a key-based interface even for a first trial" (Winkler, Rangaswamy, Tedjokusumo, & Zhou, 2007). This finding shows the link between what users rate as "intuitiveness" with tangible user interfaces and Bullinger's Communication Bandwidth (Section 2.6). Motion-based interfaces are physically moved by the user (tangible) and offer more input channels.

Table 5 is a summary of the experimental intuitive use findings discussed above. The table shows the great progress made in the field between 2003 and 2011. It is clear to see much of the advancement in the field can be attributed to Blackler and her colleagues in Australia and Hurtienne and the IUUI research group in Germany.

Table 5 Summary of Experimental Intuitive Use Findings

Source	Finding
(Blackler et al., 2003a, 2003b)	Relevant past experience is transferable between products, prior knowledge allowed participants to use features more intuitively
(Blackler et al., 2003a)	Technology familiarity score is more indicative of intuitive use than level of expertise
(Blackler, Popovic, & Mahar, 2005, p. 5)	"Intuitive use is enabled more by the appearance than the location of features"
(Hurtienne & Blessing, 2007; Langdon et al., 2008, p. 116)	"Applying the theory [image schema] leads to more intuitive user interfaces that preserve mental capacity for the task at hand"
(Jörn Hurtienne & Blessing, 2007; Langdon et al., 2008, p. 116)	Motion-based interfaces are well appreciated for their intuitiveness
(Blackler et al., 2010)	Intuitive interaction is affected by age
(Alethea Blackler et al., 2010)	"…image schema theory provides valid hypotheses for design for intuitive use"

Blackler experimentally verified that intuitive interaction is based on past experience. This agrees with one of the top scoring attributes in Table 1 and the definitions from literature in Table 2. Additional findings of technology familiarity score and age affecting intuitive use relate to Naumann's definition of "particular users", emphasizing that intuitive use changes from user to user, based on prior experience. The remaining findings stray from verifying the attributes and definitions of intuitive use. Important aspects of the definition yet to be verified include objective measures of sub-consciousness or cognitive resources and user satisfaction. The current trend in the literature points toward methods to design for intuitive use. It appears that consensus about the definition among researchers or more importantly between designers and users, has ceased. The following section describes the design methodologies developed thus far.

2.8 Design Methodologies

The most recent trends in the intuitive use literature are design methodologies. Designers are asking how to design for intuitive use. Blackler presents three design principles for intuitive use (Blackler et al., 2006):

1. Use familiar features from the same domain
2. Transfer familiar things from other domains

3. Use redundancy and internal consistency

These principles are integrated into a conceptual tool for achieving intuitive use. This is an iterative process which first assesses the user group and user familiarity. It then guides designers through design features derived from Blackler's Continuum of Intuitive Interaction presented in Section 2.6. A loop is allocated for each term or theory in the Continuum of Intuitive Interaction. Each loop has three layers representing function, appearance, and location. The layers are in order of priority; first, the function must be determined, then appearance chosen and lastly location. For more information about Blackler's conceptual tool for achieving intuitive interaction see Blackler et al. (2006).

Blackler and Hurtienne collaborate to work towards a unified view of intuitive interaction (Blackler & Hurtienne, 2007). Hurtienne proposes a checklist of principles for intuitive interaction design:

- Suitability for the task – interaction should be based on task characteristics, rather than the technology chosen to perform the task
- Compatibility – stimulus-response compatibility and proximity compatibility principle
- Consistency – internal consistency within the system and external consistency with objects outside the system
- Gestalt laws – use the basic principles of perception and transfer them to the user interface. E.g. Make objects that belong to the same task look similar
- Feedback – users must get immediate, self-evident, and appropriate feedback
- Self descriptiveness – it is obvious to the user what dialogue they are in, what actions can be taken, and how they can be performed
- Affordances – physical and virtual objects that communicate what can be done with them

For a more detailed description of each principle see Blackler & Hurtienne (2007, pp. 10–11). The principles presented by Hurtienne are similar to Blackler's and can be seen as sub-concepts of each principle to provide more detail. For example, self-descriptiveness, affordances, and suitability for the task fall under principle #1 (use familiar features from the same domain) from Blacker.

A design needs a means of being evaluated. Another product of the IUUI research group is a questionnaire called Evalint (Evaluate intuitive use). The questionnaire is designed to evaluate intuitive use with prospective users. The questionnaire comprises four scales: perceived effortlessness of use, perceived error rate, perceived achievement of goals, and perceived effort of learning. The scales of measure agree with attributes from Section 2.3, and the majority of definitions in Section 2.4. Self-reporting is a disadvantage of this questionnaire.

Loeffler claims "designing intuitive-to-use interfaces means achieving a match between the user interface and the mental model of the user" (Loeffler et al., 2013, p. 1). Her approach is a method to capture and specify the user's mental models with image schemas to introduce requirements during the design phase. This design tool is a development of Hurtienne's work with image schemata mentioned previously in Section 2.7. This method is a User Centered Design (UCD) approach with an emphasis on requirements engineering, called IBIS. IBIS has four phases, (1) preparation, (2) elicitation, (3) analysis, and (4) design. For the purposes of this thesis the analysis phase is of particular interest and is the most crucial activity in the method (Loeffler et al., 2013). The image schemata expert who analyses the transcribed sentences from the interview conducts the analysis phase and extracts image schema metaphors. The suitable metaphors are prioritized and become part of the requirements document. Two case studies with real customers from industry revealed the IBIS method resulted in more intuitive-to-use interfaces than those developed according to the UCD processes. This method is truly remarkable, "image schemas function as a common vocabulary for describing users' mental models and user interfaces, they can bridge the design gap" (Loeffler et al., 2013).

The design methodologies developed thus far are important steps to improve the intuitive use of products. Blackler gives three principles for intuitive design, Blackler and Hurtienne give a seven-point checklist of intuitive interaction, and image schemata can help translate words and phrases into design requirements for intuitive interaction. Also, a questionnaire to evaluate intuitive use is presented.

2.9 Summary

The meaning of intuition has been discussed for many years, but more recently the definition has increased in importance within the HCI field. Intuitive use is described by attributes as well as formal definitions. Hurtienne's (2011) formal definition of intuitive use is:

> *"Intuitive use is defined as the extent to which a product can be used by subconsciously applying prior knowledge, resulting in an effective and satisfying interaction using a minimum of cognitive resources" (p. 15).*

Intuitive interaction may not be the "most optimal" way from a usability standpoint, but more importantly the demand of cognitive resources are minimal (A. Naumann et al., 2007). Therefore, <u>the main focus of intuitive interaction is mental efficiency</u>, which is achieved through subconscious processes and results in a reduced cognitive workload (Israel et al., 2009).

The comparison between intuitive use and usability is made. Intuitive use is claimed to be a sub-concept of usability (Hurtienne, 2011). Therefore, designing for intuitive use may result in decreased mental effort at the expense of other usability criteria. Frameworks for intuitive use have been constructed to describe continuums of interaction and knowledge. Experimental findings verify select attributes of the definitions and many result in development of fruitful design methodologies. An example of a design methodology is IBIS. The IBIS design method is a promising way to incorporate requirements into the engineering process to make interfaces more intuitive to use. The method is grounded in image schemata theory, which is inherently subconscious. This fulfills a key aspect of intuitive use in the literature.

These findings are certainty relevant to each author's use of the term, are indeed interesting, and potentially useful. What remains to be seen is whether it represents intuitive use to Users, as opposed to the academic community. The human factors professional must ask the question: what about the User? In pursuit of intuitive use, which has full intention to benefit the user, have they been left out? We must revisit the definition to verify Users have the same definition of intuitive use as the literature suggests. Most importantly, do Users share the same understanding of intuitive use as Designers?

In 2006, Mohs presented results from a survey of naïve Users. The results generated one of the first formal definitions (Table 2) from the IUUI research group. The survey from Mohs asked for associations with intuitive operation and then asked for Users' level of agreement with 31 statements. The small number of participants (22 people), the lack of instructions to participants, and an absence of Designer participants imposed significant limitations. Input from more Users or comparison of these results with that of Users in a different culture is desirable. Moreover, this literature review demonstrates intuition crosses many fields (education, computer science, psychology etc.). Failing to give Users instruction in advance is a valid method to prevent biasing, however it can fail to give Users important context. The HCI community is interested in the definition of intuitive use within its specific context. Grounding the survey in context will yield results specific to the area of interest. Lastly, the results were only representative of naïve Users and not that of Designers. Responses from both groups would prove useful, as described below.

Evidence from the literature suggests differing views between Users and Designers. Hurtienne states, "The focus of the users' understanding is narrower than the producers' understanding of intuitive use. Users talk more about the reduction of cognitive effort in operating a product, producers talk more about user interface surface characteristics (e.g. clear layout) or general efficiency" (Hurtienne, 2011, p. 14). Therefore, because Users' focus is narrower, or potentially different than

Designers, the accurate and holistic understanding of Users by Designers is of paramount importance. For example, in the IBIS design process mentioned above and in Section 2.8. A User's request for an "intuitive interface" may initiate the use of the IBIS process to meet their needs. However, an interface with intuitive use is not the best solution for all users, tasks, and environments. Interfaces with intuitive use are best "…when designed for beginners, rare users, diverse user groups which all need to work with the same system, or users who are unwilling to learn how to operate a product." (Loeffler et al., 2013, p. 1). Therefore, it is possible a user may ask for an "intuitive interface" when in reality an alternative solution is needed.

The potential for communication error between Users and Designers motivates a clearer understanding of what each party means when using the term "intuitive use". Thus, there is a need to verify and explore additional information from both User and Designers. Assessing the level of agreement among groups will speak to the stability and validity of the foundation in which intuitive use is currently built. The infancy of the field and the uncertainty of a widely accepted definition are additional motivators to investigate these groups' meanings. The goal of this research was to verify Users' and Designers' definitions of intuitive use with each other and with the literature. Also, this research was intended to assess Users' and Designers' abilities to distinguish usability from intuitive use. Lastly, this research sought to identify guidelines and recommendations for researchers and Designers. Although intuition varies among individuals (Loeffler et al., 2013, p. 1) it is beneficial to seek trends about its meaning. With continued exploration "it is possible to further develop this concept to create guidelines for the design of intuitively usable systems and devices" (Pretz & Totz, 2007).

3 Methodology

3.1 Introduction

The literature review yielded attributes, definitions, frameworks, experimental findings, and design methodologies for intuitive use. The primary means for deriving these findings have been through the review of education, psychology and linguistics literature. Verifying select attributes experimentally developed a definition. However, there has been limited effort to explore how individuals perceive the meaning of intuitive use. Additionally, Hurtienne (Pfützner et al., 2010; Sauer, Seibel, & Rüttinger, 2010; Winkler et al., 2007) suggest that users have a different view of intuitive interaction than designers.

3.2 Research Design

The following describes the thought and justification for choosing a method to answer the research questions restated below. In addition, this study and a detailed explanation of the chosen method are discussed. This is followed by data collection, methodological limitations and the data analysis methods.

3.2.1 Research Hypothesis Restated

The literature motivated the following research questions:

1. Is there a significant gap between Users' and Designers' definitions of intuitive use?
2. Do Users' and Designers' definitions of intuitive use agree with the literature definition?
3. Can Users and Designers distinguish the attributes separating intuitive use from usability?

The following null hypotheses were derived from the research questions:

1. H_o: Users' and Designers' definitions of intuitive use are the same.

2. Part 1

   H_o: Users' definitions of intuitive use agree with the literature definition.

   Part 2

   H_o: Designers' definitions of intuitive use agree with the literature definition.

3. Part 1

   H_o: Users can distinguish attributes differentiating intuitive use from usability.

Part 2

H_o: Designers can distinguish attributes differentiating intuitive use from usability.

3.2.2 Methods

A survey method was warranted to elicit participants' definitions of intuitive use. The two basic forms of data collection are those with and those without an interviewer. Collection methods with an interviewer may be in person or via the telephone. Collection methods without an interviewer are self-administered. For example, questionnaires used in group settings (e.g. classroom) or questionnaires used in individual settings (e.g. mailed surveys conducted at the participant's home or the computerized version, an internet survey) (Leeuw et al., 2008). Each data collection method is valid for answering the proposed research questions. This research study selected an Internet survey. An Internet survey was appropriate for answering the aforementioned research questions. Because the author sought to understand both Users and Designers, a method that resulted in a larger number of participants was beneficial. Internet surveys have advantages in collecting large numbers of participants quickly, and at low cost. They also allow for consistent control and eliminate interviewer interference (Leeuw et al., 2008). In addition, this method allowed for randomization, logic, branching of questions, and comparison with Mohs' (2006) survey to potentially observe the term's evolution. Moreover, previous Internet surveys have "showed that answers to open-ended questions in email and web surveys are much richer than in other survey modes" (Leeuw et al., 2008, p. 278) because of the ease of typing a longer response. This advantage was leveraged in Section 3.2.3.4 where participants' open-ended responses were sought.

3.2.3 Survey Design

The Internet survey was used to understand how Users and Designers define the term intuitive use and uncover other factors that were associated with its use. The survey was influenced by attributes and definitions discovered in the literature review section. The following describes the survey design in detail and how it anticipated answering the research questions.

3.2.3.1 Introduction

The survey comprised seven blocks as shown in Figure 3. The blocks included: consent, demographics, open-ended response, agreement with the literature definition, intuitive use versus usability, experimental attributes and experimental attributes: open-ended response. The survey in its entirety is available in Appendix B. The order of the blocks was carefully considered. After consent and demographics, the open-ended response scenario was presented first so that participants would not be biased by other questions. The intent was to refrain from listing any attributes or phrases that might influence the open-ended responses. Next, the author sought participants' agreement with the literature definition. Then, additional attributes were presented to help distinguish intuitive use from usability. Next, a set of other attributes was presented to explore other possible attributes of intuitive use. In the last section, if the participant responded *Strongly Agree* on any of the other attributes, they were asked to give further explanation.

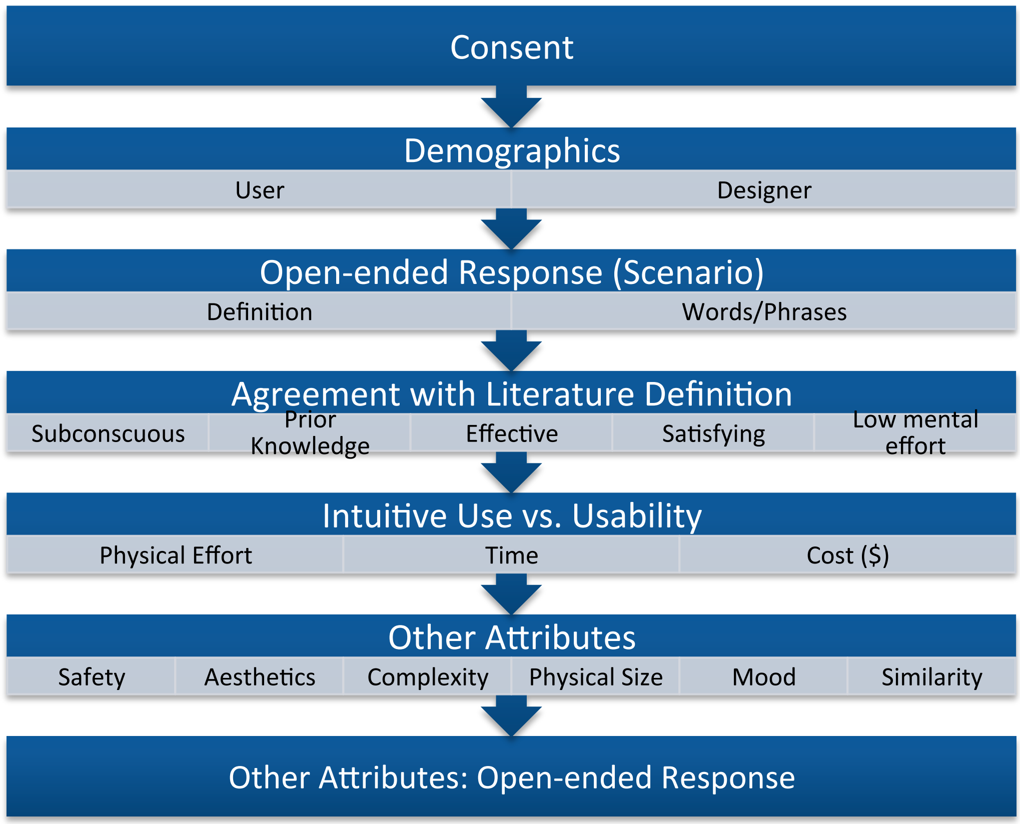


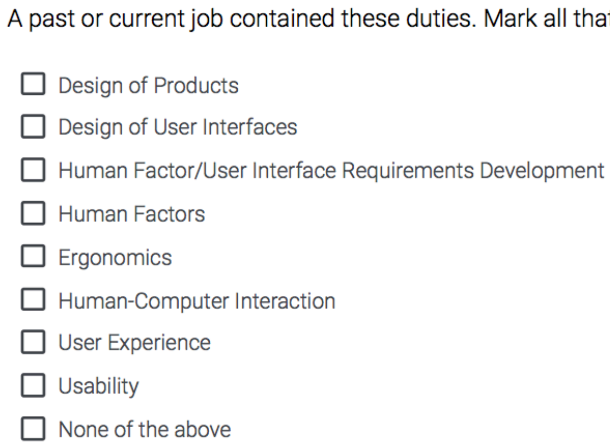
Figure 3 The Seven Main Blocks Comprising the Intuitive Use Survey

3.2.3.2 Block 1: Consent

The first block was the consent page. The consent page stated all necessary information required by the Institutional Review Board (IRB). The participant had to click "I Agree" in the bottom right corner of the page to continue to the next block.

3.2.3.3 Block 2: Demographics

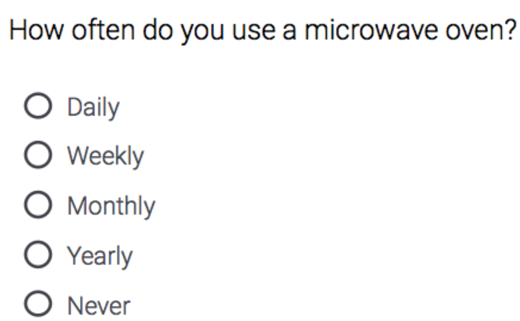
The demographics block collected demographic information. This included age, gender, level of education, job duties, frequency of microwave oven use and country of permanent residence. The most important question in this section was job duties. Job duties determined which group participants were placed in, either User or Designer. Duties were derived from a brainstorming session between the author and other Human Factors graduate students. Figure 4 shows the survey question regarding job duties used to determine participants' grouping.


A past or current job contained these duties. Mark all that apply.

- ☐ Design of Products
- ☐ Design of User Interfaces
- ☐ Human Factor/User Interface Requirements Development
- ☐ Human Factors
- ☐ Ergonomics
- ☐ Human-Computer Interaction
- ☐ User Experience
- ☐ Usability
- ☐ None of the above

Figure 4 Survey Question Regarding Job Duties, Used to Determine Participants' grouping.

Figure 5 shows the survey question regarding participant's microwave use.


How often do you use a microwave oven?

- ○ Daily
- ○ Weekly
- ○ Monthly
- ○ Yearly
- ○ Never

Figure 5 Survey Question Regarding Participant's Microwave Use

Participants could have responded to one or several job duties, however if *None of the Above* was selected, then the survey software did not allow participants to mark any other duties. If participants marked *None of the Above* they were placed in the Users group. If participants marked one or more of the job duties listed they were placed in the Designers group.

3.2.3.4 Block 3: Open-Ended Response (Scenario)

The next block asked for participant's open-ended responses to the definition of intuitive use. This block sought to qualitatively answer research questions #1 and #2. However, there was no way of knowing what past experience participants drew on to derive their definition of "intuitive". Some may have thought about a card game they found easy to play, or maybe a computer program they used at work, while others may have thought about a kitchen device they recently bought. In order to provide some structure and context to the term, a scenario was given. The scenario promoted a more controlled elicitation of definitions. As a result, participants' definitions should be more consistent. Using an appropriate scenario also grounded the survey in a context relevant to HCI. The author was interested in intuitive use as it pertains to this specific field and hoped this focused approach resulted in more pertinent results.

The scenario and type of product mentioned in the scenario were carefully thought out. The product in the scenario needed to have a careful balance of complexity. Something too simple like a pencil might have restricted responses, while something more complex, like a smartphone, may have been too broad. The product need not have been trivial, but should have provided the opportunity for error in use. An additional constraint required a product that a majority of participants would have experience with so as to not limit the potential number of participants. It was decided a microwave oven would meet these requirements. Microwaves have become ubiquitous and would minimally limit potential respondents. A microwave contains an adequate level of function and complexity. Additionally, research by Blackler (2009; 2006; 2014) used microwave interfaces as a basis for testing her Conceptual Tool for Intuitive Use. All of these factors made a microwave a satisfactory choice for this scenario.

Once the product was chosen it was incorporated into a scenario for the participant to read. The scenario presented to the participant was as follows:

> *Sarah just received a new microwave oven as a gift to replace her old one, which she owned for several years. That evening she unboxed the new microwave for the first time and reheated her food. Afterward, she called her friend to tell her "My new microwave is very* ***intuitive*** *to use."*

The scenario contained three important components:

1. Sarah had an existing microwave for several years (*which she owned for several years*)
2. Sarah's new microwave was a gift and was newly received (*just received a new microwave oven as a gift*)
3. The first time operation of her new microwave resulted in an intuitive use (*for the first time and reheated her food*)

The first component established Sarah's prior knowledge with her existing microwave. This told the participant Sarah was experienced with her microwave and presumably had no difficulty operating it. The second component communicated that Sarah's new microwave was not selected by her and she had no prior experience with that specific microwave. The last component showed Sarah's first use was successful and she classified it as "*very **intuitive** to use.*" This scenario was the ideal setting for intuitive interaction: an interaction with a new product that resulted in an intuitive use because of the subconscious application of prior knowledge. This scenario demonstrated "achieving a match between the user interface and the mental model of the user" (Loeffler et al., 2013, p. 1).

Once the scenario was presented, the participant was asked to provide what they thought Sarah's definition of the word "intuitive" was. The prompt provided was:

> *"What do you think Sarah means when she uses the word intuitive? That is, what do you think Sarah's definition of intuitive is?"*

The following question asked for words or phrases that were synonymous with the word "intuitive". The prompt provided was:

> *"What words or phrases do you think are roughly synonymous with (have about the same meaning as) intuitive? (Example: Word 1, Word 2, Phrase 1, Phase 2, etc.)"*

These questions sought to extract unbiased information about the word "intuitive" before any attributes were introduced from the literature.

3.2.3.5 Block 4: Agreement with Literature Definition

The fourth block was concerned with the levels of agreement with the literature definition. This block sought to quantitatively answer research question #1 and #2. As seen in Section 2.4, there are many definitions of intuitive interaction presented in the literature. The definition used in this survey was that which is presented by Hurtienne (2011) in Table 2. This definition was chosen because it reflects the most recent and refined definition uncovered in the literature review. Hurtienne's (2011) definition is as follows:

> *"Intuitive use is defined as the extent to which a product can be used by subconsciously applying prior knowledge, resulting in an effective and satisfying interaction using a minimum of cognitive resources" (p. 15).*

The attributes extracted from Hurtienne's definition are:

1. *Subconscious*
2. *Prior knowledge*

3. *Results are effective*
4. *Results are satisfying*
5. *Low mental effort*

To verify participants' level of agreement with the literature definition, a question was written for each attribute. Multiple questions were written for each attribute during the construction of the survey, however only one question for each attribute was included to minimize survey length and reduce premature termination. Questions were written in both positive ways and a negative ways to keep the tone of the survey balanced ("How to Write Good Survey and Poll Questions," n.d.); similar to the System Usability Scale (SUS), which used alternating positive and negative questions (Brooke, 1996). Additionally, the survey used by Mohs (2006) to derive a definition of intuitive use contained negative questions as well. The technique used to analyze positive and negative questions is described in Section 3.5.1. Table 6 shows a mapping of the attributes to the survey questions. The questions were presented in a random order for each participant and drew on the scenario established in the previous block. A "+" or "-" next to the attribute indicates if a question was worded in a positive or negative way. The prompt provided was:

"Please indicate your level of agreement for each statement with respect to Sarah's statement 'My new microwave is very intuitive to use.'"

Table 6 Mapping of Literature Attributes to Survey Questions. A "+" or "-" indicates if a questions was worded in a positive or negative way.

Attribute	Question
Subconscious (+)	Sarah said her new microwave was intuitive to use because she could use it **subconsciously**.
Prior knowledge (+)	Sarah said her new microwave was intuitive to use because she could use **prior knowledge** from her old microwave.
Results are effective (-)	Sarah said her new microwave was intuitive to use because she **made errors** when using it.
Results are satisfying (+)	Sarah said her new microwave was intuitive to use because it was **satisfying** to operate.
Low mental effort (-)	Sarah said her new microwave was intuitive to use because she **thought deeply** about how to make it do what she wanted.

The response scale and the way it was displayed were carefully thought out. The choice of a five-point Likert scale was made. Dawes (2012) showed five-point and seven-point scales yield no differences in mean responses once rescaled. However, there was statistical significance when compared to ten-point scales. Because the survey might be completed on mobile devices with smaller screens, a smaller point scale was favored. A five-point Likert scale was used for all questions seeking level of agreement. In addition to the five-point scale a sixth option, *No Opinion*, was added to the right side of the scale. The middle of the five-point scale was *Neutral* intended to mean the participant had an opinion but it was neither agreement nor disagreement. *No opinion* meant the participant did not have a level of agreement and therefore had no opinion on the statement. If *No Opinion* was not present the author was concerned participants with no opinion would mark *Neutral* and skew results. Additionally, participants with no opinion may have not responded to the question, making it appear as though the question was skipped. For these reasons, *No Opinion* was added as an option.

Next, the display of the scale was chosen. One option was a drop-down menu. Drop-down menus can be used to make surveys appear shorter, however they are more burdensome for respondents and may cause participants to abandon the survey (Leeuw et al., 2008). Therefore, the response scale was visible and was not contained in a drop-down menu. Figure 6 shows an example of a question in this block with the Likert scale depicted below.

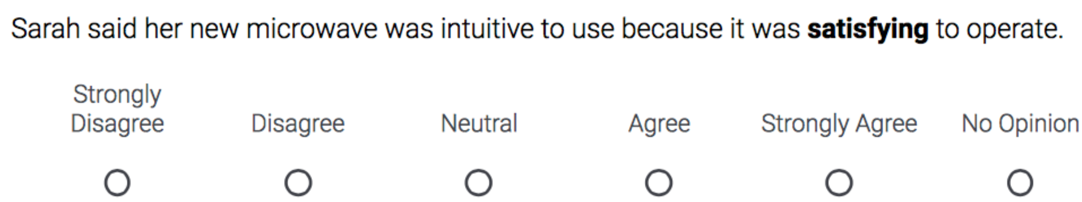


Figure 6 Example of a Question Present in Block Four with the Likert Scale Depicted Above.

3.2.3.6 Block 5: Intuitive Use versus Usability

The fifth block was for intuitive use versus usability. This block sought to qualitatively answer research question #3. This block was used to determine how participants perceive three attributes that distinguish usability from intuitive use. Hurtienne claims intuitive use is a sub-concept of usability. Table 3 presented in Chapter 2 shows the three attributes of usability that are not associated with intuitive use. These are:

- *Users' physical effort*
- *Task completion time*
- *Cost*

To verify participants' level of agreement with Hurtienne's distinction, a question was written for each attribute. Again, multiple questions were written for each attribute, however only one question for each attribute was included to minimize survey length. Table 7 shows a mapping of the attributes to the survey questions. The questions were presented in a random order for each participant and drew on the scenario established in the third block. This block uses the same response scale described in Section 3.2.3.5. The prompt provided was:

"Sarah made the statement, 'My new microwave is very intuitive to use.' Please indicate your level of agreement with each statement below."

Table 7 Mapping of Attributes distinguishing Intuitive Use from Usability to Survey Questions

Attribute	Question
Users' physical effort	Sarah's new microwave can be intuitive to use regardless of the **physical effort** it takes to operate.
Task completion time	Sarah's new microwave can be intuitive to use regardless of the **time** it takes to operate.
Cost	Sarah's new microwave can be intuitive to use regardless of its **cost ($)**.

3.2.3.7 Block 6: Other Attributes

The sixth block was other attributes. This block was intended to gain additional insights into the term's use and potentially support research questions #1, #2, and #3. The attributes in this block do not appear in the definitions presented in the literature, nor did they surface in the attributes table (Table 1) of the literature review. The purpose of this section was to potentially uncover other attributes of products or interfaces that may affect one's perception of intuitive use. Some of the attributes were discussed in the literature review for example, aesthetics (Israel et al., 2009; A. Naumann et al., 2007; A. B. Naumann et al., 2008), level of complexity (Israel et al., 2009; A. Naumann et al., 2007; A. B. Naumann et al., 2008), and similarity (Blackler et al., 2010). Additional attributes were derived from a brainstorming session between the author and other Human Factors graduate students. The other attributes were as follows:

- *Safety*
- *Aesthetics*
- *Level of complexity*
- *Physical size*
- *Mood*
- *Similarity*

The other attributes were placed in a matrix format, as seen in Figure 7. This was used to make the survey appear shorter, reduce redundancy, and require less effort (Leeuw et al., 2008). This research sought to distinguish the other attributes relative to each other. Questions in a matrix are seen as one unit and placed in a comparative framework (Couper, 2001). The choice of question design encouraged participants to indicate the most important within the given choices. This is reflective of a designer's challenge to prioritize requirements. This question was intended to lend some insight to preferences and prioritization of Users versus Designers. The matrix drew on the scenario established in the third block. The prompt provided was:

The following affect how intuitive Sarah's microwave is to use.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
Safety	○	○	○	○	○	○
Similarity to her previous microwave	○	○	○	○	○	○
Level of Complexity	○	○	○	○	○	○
Physical Size	○	○	○	○	○	○
Aesthetics	○	○	○	○	○	○
Sarah's Mood	○	○	○	○	○	○

Figure 7 Matrix Format of Experimental Attributes

3.2.3.8 Block 7: Other Attributes: Open-ended Response

The seventh and final block was other attributes: open-ended response. This section only appeared to participants who indicated *Strongly Agree* on any of the other attributes in the previous block; otherwise they were directed to the end-of-survey message. Additionally, this section was only populated with open-ended response questions for attributes that the participant indicated *Strongly Agree*, meaning this section ranged from one to six questions. The prompt structure provided was:

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "Strongly Agree" about [other attribute]. Please provide an explanation below.

Where *other attribute* was replaced with the corresponding attribute. The purpose of this section was to gain further insight into the participant's response. A detailed description indicating why they strongly agreed could potentially uncover additional information about the terms use.

3.3 Data Collection and Participants

3.3.1 Data Collection

The survey was built and tested with the Qualtrics web-based survey software ("Oregon State University - Qualtrics," n.d.). Data collection was also conducted via Qualtrics. Once completed, Qualtrics generated a Uniform Resource Locator (URL) that was used to direct participant's web browser to the online survey. All response data captured through the Qualtrics online survey was stored in the Qualtrics database. Once the survey was closed the data was downloaded from Qualtrics to be analyzed in other software packages.

3.3.2 Participants

As described in the literature review section, an initial survey of "naïve users" was conducted by Mohs (2006). Mohs described his participants as, "A total of 22 people (including 10 women) were interviewed, the average age was 38.7 years. The participants were chosen with respect to heterogeneity in terms of educational level and occupation." (Mohs, Hurtienne, Scholz, et al., 2006, p. 2). There were no additional details about the source or recruitment methods of these participants. The present study also sought to reach a heterogeneous group of participants and improve upon the number of participants. This was attempted through varying recruitment methods. Participants were recruited through the following channels:

- In person
- Email
- Telephone (voice and text message)
- Posted flyers
- Social media (Facebook and Twitter)
- Internet (such as LinkedIn and topic applicable blogs/websites)

Recruitment strategies were pursued with the intension of reaching each group (Users and Designers) specifically as well as together. For example, Designers were reached through Human Factors and User Experience Linkedin pages, Users were reached by posting flyers on bulletin boards around Oregon State University's campus, and both were reached through social media and individually sent emails. Email invitations included an encouragement to forward the survey to colleagues. Contact information was obtained through public records or as a result of previous contact. IRB approval, recruitment documents and flyers are included in Appendix C.

Participants were not restricted based on gender or ethnic group. The criteria for enrollment was that each participant be 18 years or older. There was no targeting of any vulnerable population of children, pregnant women, prisoners, non-English speakers, non-literate participants, or adults lacking capacity to consent. There were no foreseeable risks associated with the study and participants did not receive any compensation.

The recruitment strategy listed above was chosen in an attempt to access a broad population. The use of paper flyers as well as online avenues was used in an attempt to maximize the coverage of the study. The author acknowledges recruitment through university bulletin board posts and other online methods may lead to coverage error. Inherent limitations with Internet surveys and sampling limitations are discussed in Section 3.4.

3.4 Methodological Limitations

A major limitation with Internet surveys is coverage error, especially when the target population is the general public. This limitation is "less critical for web surveys aimed at Internet users only and for web surveys of special populations where all or most of the members have Internet access" (Leeuw et al., 2008, p. 269). The study was conducted from the United States, which has good Internet coverage. According to The World Bank, in 2013, 84.2% of the United States had access to the Internet ("Internet users (per 100 people)," 2015). While not perfect, this level of access is deemed acceptable. Additionally, this study focused on the HCI field, and while this is not the intent or focus of this study, obtaining coverage error from those without Internet access is an acknowledged and acceptable limitation. If the Internet survey were targeted towards participants in countries with lower access levels, a different method would need to be used.

Other limitations of Internet surveys pertain to their self-administered nature. There is no interviewer present if difficulties arise and participants may vary in computer skills. Also, variations in visual design may occur depending on apparatus factors such as the use of computers, tablets, and smartphones and their respective display size and resolution (Leeuw et al., 2008). Additionally, there is no way to control the environment the participant takes the survey in. This could lead to distractions while taking the survey or the possibility of using additional resources like other individuals, books, or Internet sources. There was also no way to verify that the demographic information the participant indicated was accurate and true. Theses limitations are recognized by the researcher and deemed acceptable for this study.

Finally, there are limitations with the sampling method of participants. The sampling method described in Section 3.3.2 was not random, but voluntary from the population. Internet posts via social media, websites or blogs recruited voluntary participants that could contain an inherent bias. The voluntary nature of the sampling implies the author could not generalize the results to a larger population; meaning the results obtained through this study can only speak for this sample of participants and could differ from the true population average.

3.5 Analysis

3.5.1 Positively and Negatively Worded Questions

The mean values of negatively worded questions were "converted" when data was displayed in some tables so that they might be compared with positive questions more easily. Converted values are indicated in the table description. The Likert scale used is shown in Figure 19. The mean values were "converted" by mirroring the values across the middle (3- *Neutral)* of the Likert scale. For example, if a participant responded *Disagree* (2) for a negatively worded question, the converted response is *Agree* (4). If a participant responded *Strongly Disagree* (1) for a negatively worded question, the converted response is *Strongly Agree* (5). If a participant responded *Neutral* (3), the response was unchanged. Conversion of mean values assumes that disagreeing with an attribute and agreeing with an attribute's opposite are the same. For example, this assumes a participant who disagreed with the statement, "intuitive use means many errors are made when using an interfaces" would also equally agree with the statement, "intuitive use means few errors are made when using an interface".

3.5.2 Coding

Open-ended responses were coded using the same method described in Section 2.3. Each participant's response was read through and codes were generated for that response. Responses with common codes were grouped. For example, if a participant mentioned the word "quick" and another mentioned the word "fast", both participants' responses counted toward one code called "quick/fast". Coding was done using Microsoft Excel 2011 Version 14.5.1.

3.5.3 Statistical

The analysis reflected several considerations to meet the constraints of this study. The Likert scale produced nominal or ordinal data – that is data on an arbitrary numeric scale. Qualtrics Survey Software coded the Likert scale responses into numbers. For example, when a participant indicated *Strongly Disagree* it was coded as the number one. Therefore, the analysis method must be suitable for nominal data. Next, the analysis method needed to be non-parametric "because categorical [ordinal or nominal] data are not normally distributed, non-parametric methods are generally more appropriate" (Hollingsworth, Collins, Smith, & Nelson, 2011, p. 2). Additionally, non-parametric methods should be used when data violate unequal variance or homoscedasticity (Hollingsworth, Collins, Smith, & Nelson, 2011, p. 2). The analysis method must also allow for unequal group sizes, in the likely scenario there are unequal participants in each group (Users and Designers).

Considering the previous constrains, the Pearson Chi-square test, or simply the Chi-square test was used. The Chi-square test "is one of the most useful statistics for testing hypotheses when the variables are nominal" (McHugh, 2013, p. 143). This satisfies the nominal data constraint addressed above. The Chi-square test is a non-parametric or distribution-free test; hence this addresses the concern for non-parametric data. Next, the Chi-square test can be used when groups are equal or unequal in sample size. Lastly, the assumptions of the Chi-square test were checked. The assumptions of the Chi-square test are as follows (McHugh, 2013):

1. Data were obtained through random selection.
2. The data in the cells are frequencies, or counts.
3. The levels (or categories) of the variables are mutually exclusive. That is, a particular subject fits into one and only one level of each of the variables.
4. Each subject may contribute data to one and only one cell in the χ^2.
5. The study groups are independent.
6. There are 2 variables, and both are measured as categories, usually at the nominal level.
7. The value of the cell *expecteds* should be 5 or more in at least 80% of the cells, and no cell should have an expected of less than one

All assumptions of the test were met with exception of assumption #1. The limitation of random sampling is addressed in Section 3.4 and this violation was deemed acceptable to advance with the current analysis method. Assumption #7 is addressed in Chapter 4. In the event assumption #7 is not met, similar Likert scale categories were be combined (Elliott & Woodward, 2007).

This analysis method provided information on the significance of observations between two groups (Users and Designers). Essentially, the Chi-square method can lend insights to the similarity or differences of Users and Designers on the Likert scale responses. The analysis was chosen to assist in answering research question #1 and to give additional information for research questions #2 and #3. Other analysis methods used were descriptive statistics and histograms. All statistical analysis was completed using IBM SPSS Version 22. These methods are used to characterize the responses and visualize data between the Users and Designers.

3.6 Summary

This chapter described the method to answer the research questions derived from the literature review, (1) is there a significant gap between Users' and Designers' definitions of intuitive use?; (2) do Users' and Designers' definitions of intuitive use agree with the literature definition?; (3) can Users and Designers distinguish the attributes separating intuitive use from usability?

The chosen method was an Internet survey conducted via Qualtrics web-based survey software. This method allowed for collecting data from a large number of participants quickly and at low cost (Leeuw et al., 2008). Additionally, previous Internet surveys "showed that answers to open-ended questions…are much richer than in other survey modes" (Leeuw et al., 2008) because the ease of typing a longer response. This was beneficial for collecting participants' definitions of intuitive use. The survey comprised seven blocks: consent, demographics, open-ended response, agreement with the literature definition, intuitive use versus usability, other attributes and other attributes: open-ended response. Throughout the survey reference to a scenario in Block 3 was used to ground the survey in context relevant to HCI. Open-ended responses were captured in a freeform text box and level of agreement on a 5-point Likert scale, with a sixth option of *No Opinion.*

Participants in the study were recruited through the following channels: in person, email, telephone, posted flyers, social media, and the Internet. Participants must have been 18 years or older and did not receive any compensation for taking part in the study. Limitations of the methodology were addressed and data analysis methods were proposed.

4 Results

4.1 Introduction

This chapter presents results from the web-based survey. The survey was conducted between April 24th, 2015 and May 6th, 2015. The average survey duration was 13 minutes and there was an 86% completion rate. First, participants' demographic information from Block 2 is presented in Section 4.2.1. Next, participants' open-ended responses from Block 3 are presented in Section 4.2.2. Then, the 14 attributes tested in the survey are presented in Sections 4.2.3, 4.2.4, and 4.2.5. Finally, open-ended responses from the other attributes are presented in Section 4.2.6.

4.2 Survey Results

4.2.1 Block 2 Results: Demographics

The following shows results from Block 2: demographics. In order to place participants into the correct group, either User or Designer, the question regarding job duties was analyzed first. This grouping of the participants will be used in presenting the remainder of the results. A total of 134 participants responded to the survey, 134 (100%) responded to the question regarding job duties. The grouping methodology described in Section 3.2.3.3 was used. Out of 134 participants, 41 (30.6%) were considered Users and 93 (69.4%) were considered Designers, as seen in Figure 8. The results show the Designer group was over twice as large as the User group.

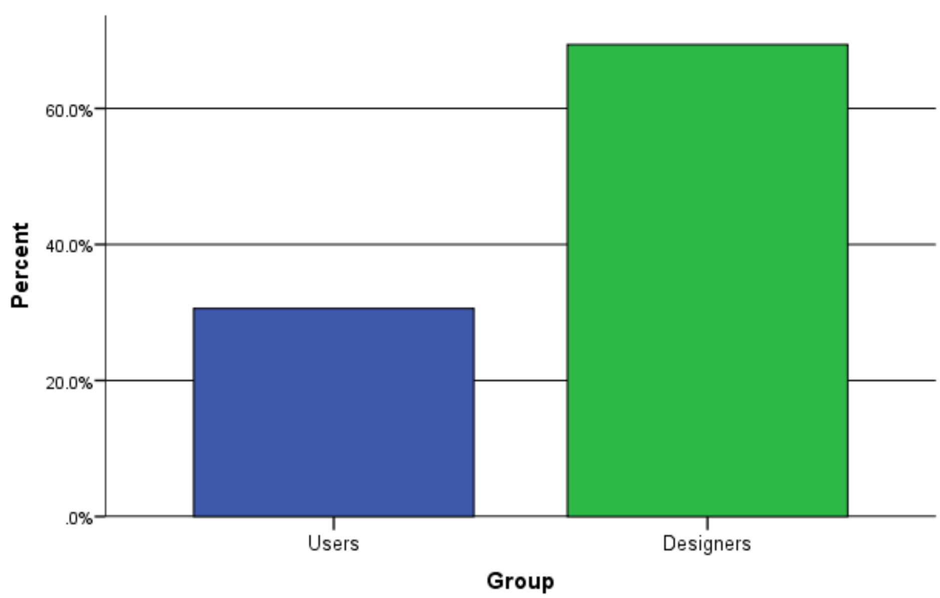


Figure 8 Number of Users vs. Designers

Table 8 presents the number of users and designs by job duties. Aligning with the grouping methodology in Section 3.2.3.3, Users indicated *None of the above* for job duties. However, Designers indicated one or more job duties, the most frequent being HCI (68.8%), UX (60.2%) and usability (51.6%). The average number of job duties indicated by Designers was 3.7. Figure 9 presents a graph of the sum of job duties for designers using the data from Table 8.

Table 8 Number of Users and Designers by Job Duties

Number of Users and Designers by Job Duties											
Group			Design of Products	Design of UI	HF/UI Req. Devel.	HF	Ergonomics	HCI	UX	Usability	None of the above
Users	N	Valid	0	0	0	0	0	0	0	0	41
		Missing	41	41	41	41	41	41	41	41	0
Designers	N	Valid	32	45	33	48	22	64	56	48	0
		Missing	61	48	60	45	71	29	37	45	93

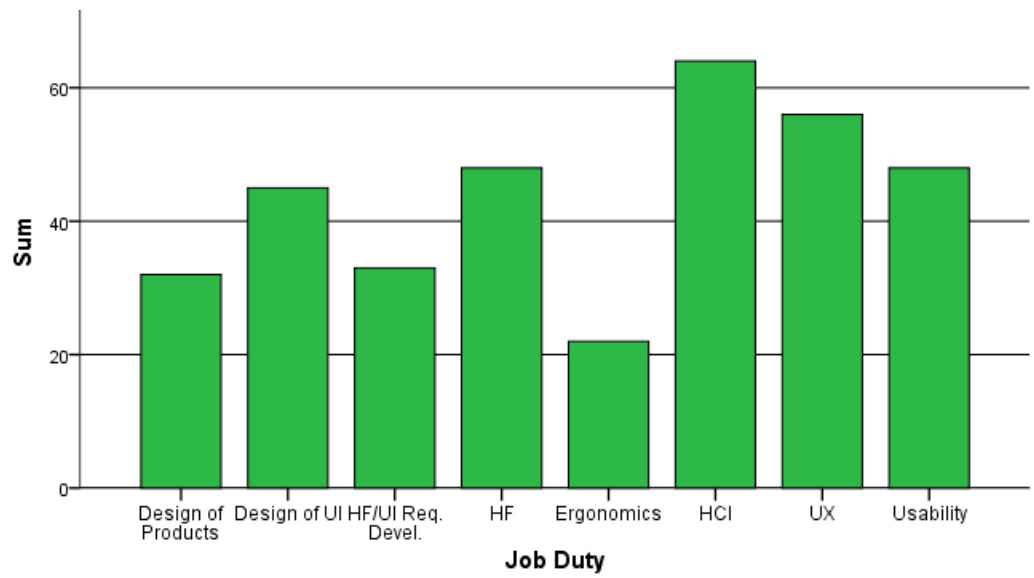


Figure 9 Sums of Job Duties for Designers

A total of 134 participants responded to the survey, 132 (98.5%) responded to the question regarding age. Figure 10 presents the distribution of total participants' age ranges in years. The lower age ranges received more participants with a decrease in participants as the age range increased.

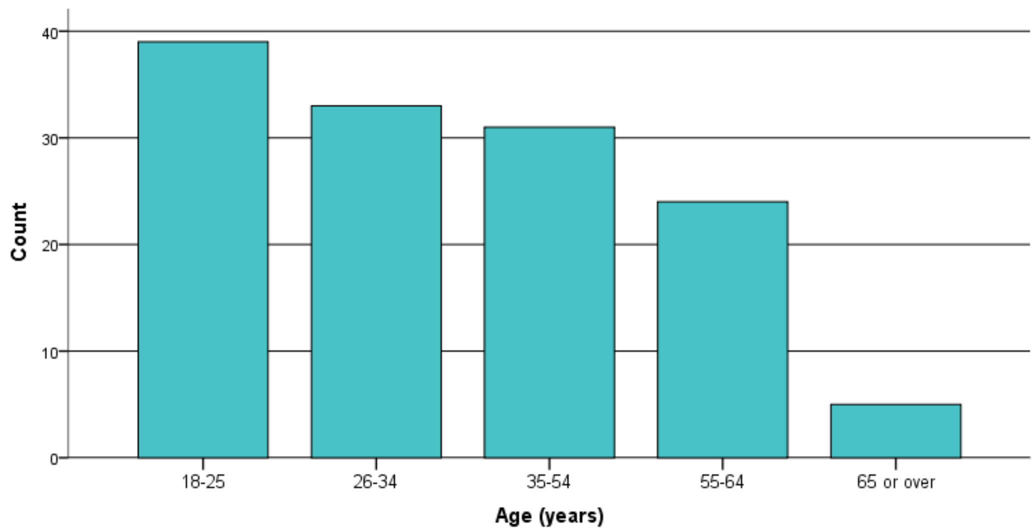


Figure 10 Distribution of Total Participants' Age Ranges in Years

Table 9 presents the number of Users and Designers by Age in years. All age ranges included participants. Out of the 132 participants who responded to this question, 40 were Users and 92 were Designers.

Table 9 Number of Users and Designers by Age (years)

Number of Users and Designers by Age (years)							
		Age (years)					Total
		18-25	26-34	35-54	55-64	65 or over	
Group	Users	15	8	9	7	1	40
	Designers	24	25	22	17	4	92
Total		39	33	31	24	5	132

Figure 11 shows the distributions of Users' vs. Designers' age ranges in years. The y-axis is graphed on a percent scale to easily compare the age ranges in the face of unequal group size. The Users' group contained a larger percentage of responses in the 18-25 age range than the Designers' group, 37.5% compared to 26.1%, respectively. However, the Designers' group contained a larger percentage of responses in the 26-34 age range than the Users' group, 27.2% compared to 20.0%, respectively. The remaining age ranges were similar for both groups.

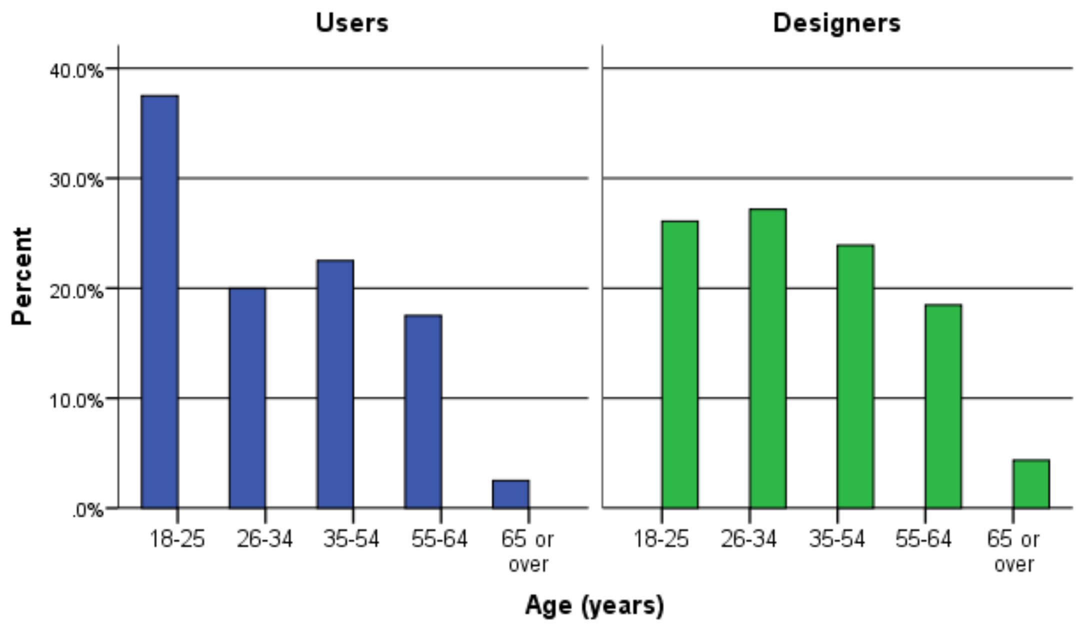


Figure 11 Distributions of Users' vs. Designers' Age in Years

Out of 134 participants, 133 (99.3%) responded to the question regarding gender. Figure 12 presents the distribution of total participants' gender. Gender was fairly balanced; there were 61 (45.9%) male participants and 72 (54.1%) female participants. No participants indicated *other (please specify)* for gender.

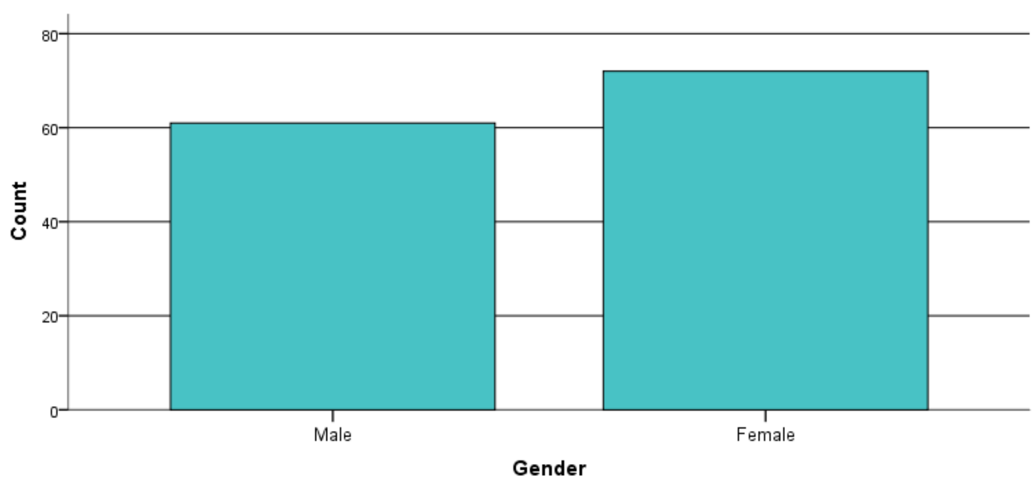


Figure 12 Distribution of Total Participants' Gender

Table 10 presents the number of Users and Designers by gender. Both groups included male and female participants. Out of the 133 participants who responded to this question, 40 were Users and 93 were Designers.

Table 10 Number of Users and Designers by Gender

Number of Users and Designers by Gender				
		Gender		Total
		Male	Female	
Group	Users	13	27	40
	Designers	48	45	93
Total		61	72	133

Figure 13 shows the distributions of Users' vs. Designers' gender. The y-axis is graphed on a percent scale to easily compare the gender in the face of unequal group size. The Users' group contained a larger percentage of female participants (67.5%) than male participants (32.5%). However, the Designers' group contained a more even distribution of male and female participants, 51.6% and 48.4%, respectively.

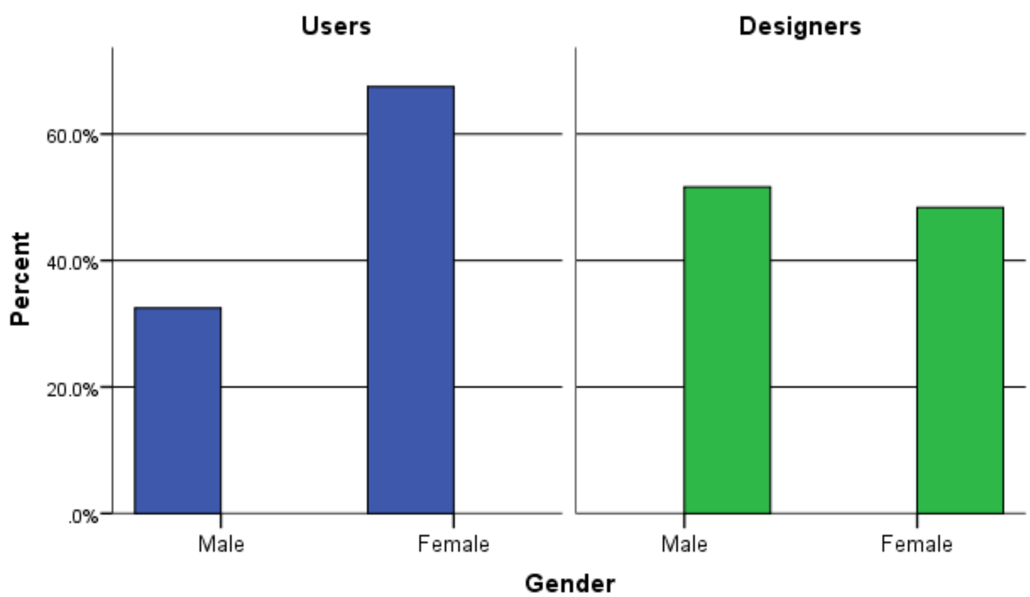


Figure 13 Distributions of Users' vs. Designers' Gender

Table 11 presents the number of Users and Designers by highest level of education completed. Out of 134 participants, 133 (99.3%) responded to the question regarding level of education completed. Most participants indicated *Some College, 4-year College Degree, or Masters Degree;* those three categories accounted for 82.0% of all participants.

Table 11 Number of Users and Designers by Highest Level of Education Completed

Number of Users and Designers by Highest Level of Education Completed										
		What is the highest level of education you have completed?								Total
		High School / GED	Some College	2-year College Degree	4-year College Degree	Masters Degree	Doctoral Degree	Professional Degree (JD, MD)	Other	
Group	Users	1	11	3	12	10	2	0	1	40
	Designers	3	15	5	36	25	6	1	2	93
Total		4	26	8	48	35	8	1	3	133

Figure 14 shows the distributions of Users' vs. Designers' level of education. The y-axis is graphed on a percent scale to easily compare level of education in the face of unequal group size. The Users' group contained a larger percent of participants with *Some College* than the Designers' group, 27.5% and 16.1%, respectively. The Designers' group contained a larger percentage of responses with a *4-year College Degree* than the Users' group, 38.7% and 30.0%, respectively. Other levels of education between groups were not notable.

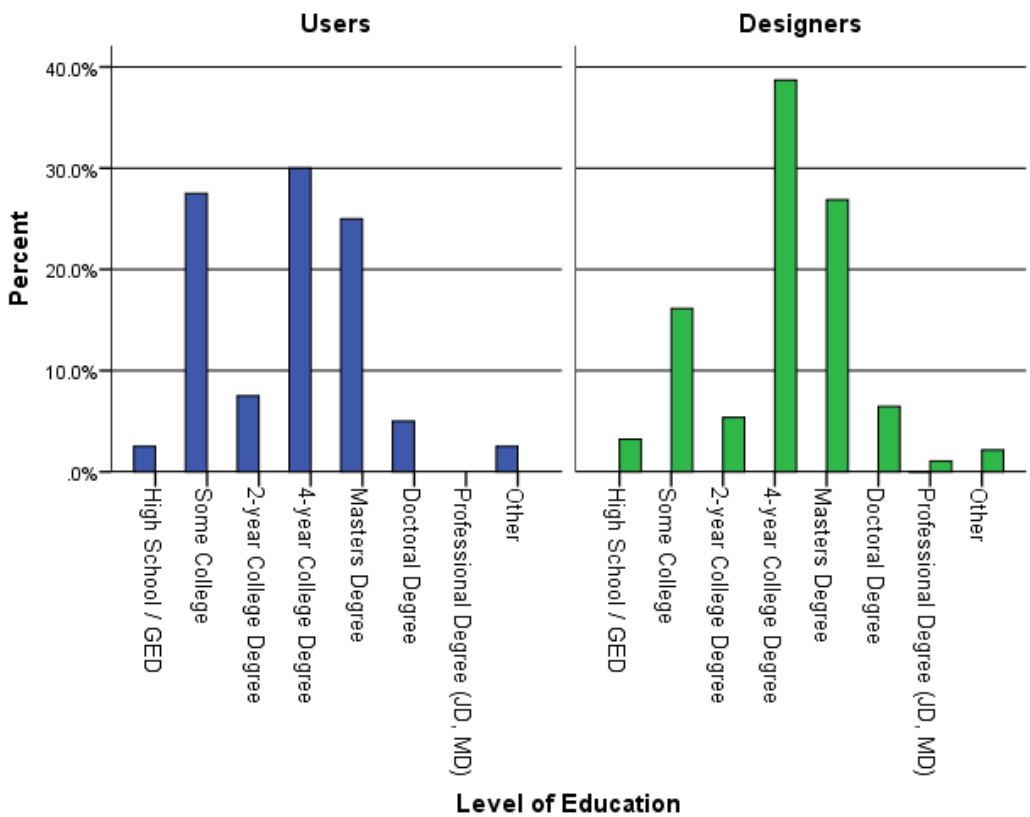


Figure 14 Distributions of Users' vs. Designers' Level of Education

Table 12 presents the number of Users and Designers by microwave oven use. This question is relevant because the scenario in Block 3 of the survey used a microwave as an example. Out of 134 participants, 133 (99.3%) responded to the question regarding microwave use. There were a total of 5 participants who indicated they *never* use a microwave oven.

Table 12 Number of Users and Designers by Microwave Oven Use

Number of Users and Designers by Microwave Oven Use							
		How often do you use a microwave oven?					Total
		Daily	Weekly	Monthly	Yearly	Never	
Group	Users	18	16	4	1	1	40
	Designers	55	26	7	1	4	93
Total		73	42	11	2	5	133

Figure 15 shows the distributions of Users' vs. Designers' frequency of microwave use. The question asked of the participants is displayed on the bottom of the graph. The y-axis is graphed on a percent scale to easily compare the frequency of microwave use in the face of unequal group size. The Users' group contained a smaller percent of participants with *Daily* microwave use than the Designers' group, 45.0% and 59.1%, respectively. However, The Users' group contained a larger percentage of responses with *Weekly* microwave use than the Designers' group, 40.0% and 28.0%, respectively.

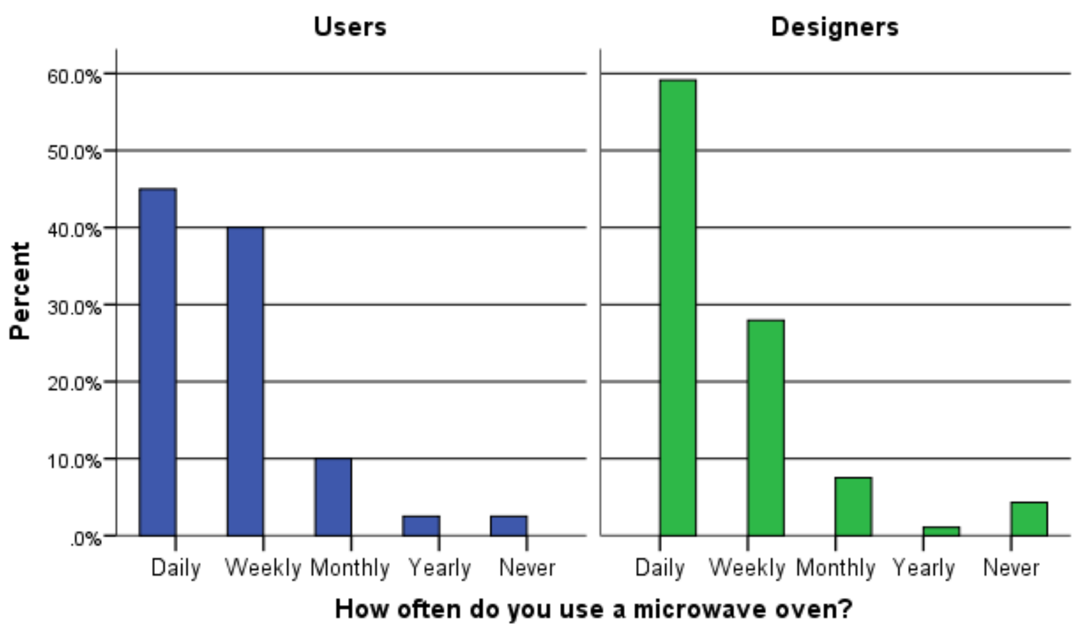


Figure 15 Distributions of Users' vs. Designers' Frequency of Microwave Use

Out of 134 participants, 129 (96.3%) responded to the question regarding country of permanent residence. Figure 16 presents the distribution of total participants by country of permanent residence. Almost all of the participants were from the United States of America, 117 (90.7%). In total, there were participants from seven different countries. Table 13 presents the number of Users and Designers by country of permanent residence. Out of the 129 participants who responded to this question, 38 were Users and 91 were Designers.

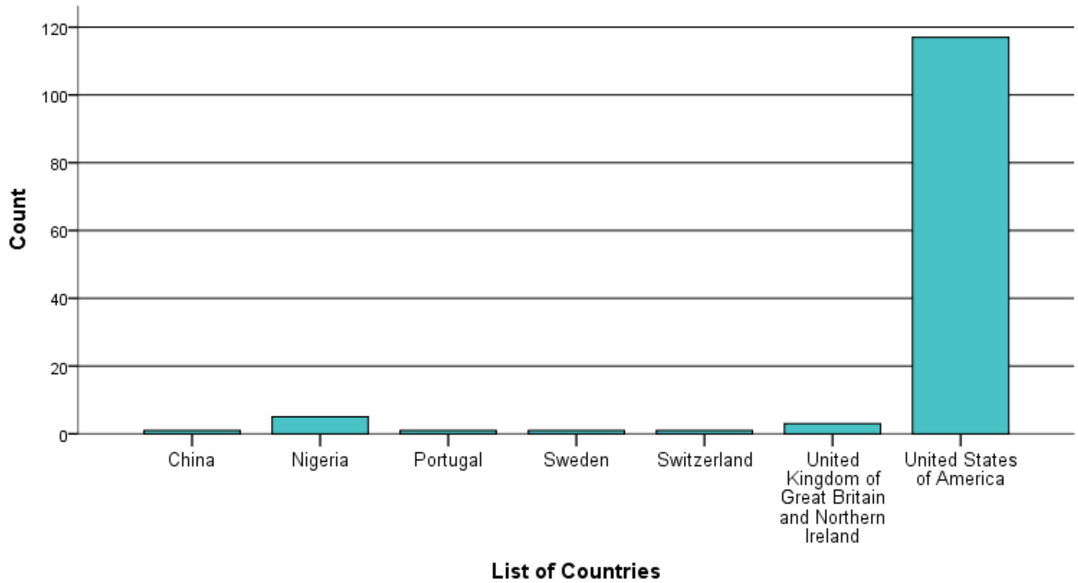


Figure 16 Distribution of Total Participants by Country of Permanent Residence

Table 13 Number of Users and Designers by Country of Permanent Residence

Number of Users and Designers by Country of Permanent Residence									
		List of Countries							Total
		United States of America	China	Nigeria	Portugal	Sweden	Switzerland	U.K. of GB and Northern Ireland	
Group	Users	36	0	2	0	0	0	0	38
	Designers	81	1	3	1	1	1	3	91
Total		117	1	5	1	1	1	3	129

4.2.2 Block 3 Results: Open-Ended Response (Scenario)

Table 14 shows the top 15 attributes from the open-ended definitions arranged by total percent. Out of 134 participants, 117 responded to the question regarding this attribute. From those responses, 34 were Users and 83 were Designers. A total of 22 attributes were identified in participants' definitions. A complete table with all 22 attributes is included in Appendix C. The most frequently cited attributes observed for all participants were: Easy, Easy to use/understand/learn (60.7%); No instruction/manual (35.9%); Reference made to buttons, controls, interface, or functions (25.6%); Use was correct, successful, effective, met her goal or did what she wanted (18.8%); and Use of past experience/expectations (15.4%).

Table 14 Top 15 Attributes of Open-ended Definitions Arranged by Total Percent

		Group					
#	Attribute	User (Count out of 34)	User (%)	Designer (Count out of 83)	Designer (%)	Total (Count out of 117)	Total (%)
1	Easy, Easy to use/understand/learn	20	58.8%	51	61.4%	71	60.7%
2	No instruction/manual needed	16	47.1%	26	31.3%	42	35.9%
3	Reference to buttons, controls, interface, or functions	8	23.5%	22	26.5%	30	25.6%
4	Use was correct, successful, effective, met her goal or did what she wanted	4	11.8%	18	21.7%	22	18.8%
5	Use of past experience/expectations	3	8.8%	15	18.1%	18	15.4%
6	Use was logical or makes sense	8	23.5%	9	10.8%	17	14.5%
7	Requires no learning/training	3	8.8%	8	9.6%	11	9.4%
8	Similar or familiar	3	8.8%	7	8.4%	10	8.5%
9	Simple	1	2.9%	9	10.8%	10	8.5%
10	Use was quickly or automatic	1	2.9%	8	9.6%	9	7.7%
11	User friendly	2	5.9%	5	6.0%	7	6.0%
12	Works the first time/try	2	5.9%	5	6.0%	7	6.0%
13	No explanation necessary or self-explanatory	0	0.0%	6	7.2%	6	5.1%
14	No thought is needed	1	2.9%	5	6.0%	6	5.1%
15	Matches her mental model	0	0.0%	5	6.0%	5	4.3%

User and Designers had similar percentages for attributes #1, 7, 8, 11, and 12. However, there were notable differences between attributes #2, 6, 9, and 13. Attribute #2, *No instruction/manual,* was mentioned by 47.1% of Users compared to 31.3% of Designers. Attribute #6, *Use was logical or makes sense,* was mentioned by 23.5% of Users compared to 10.8% of Designers. Attribute #9, *Simple,* was mentioned by 2.9% of Users compared to 10.8% of Designers. Attribute #13, *No explanation necessary or self-explanatory,* was mentioned by 0.0% of Users compared to 7.2% of Designers. Figure 17 displays the data from Table 14 graphically, showing the top 15 attributes of open-ended definitions arranged by total percent for each group.

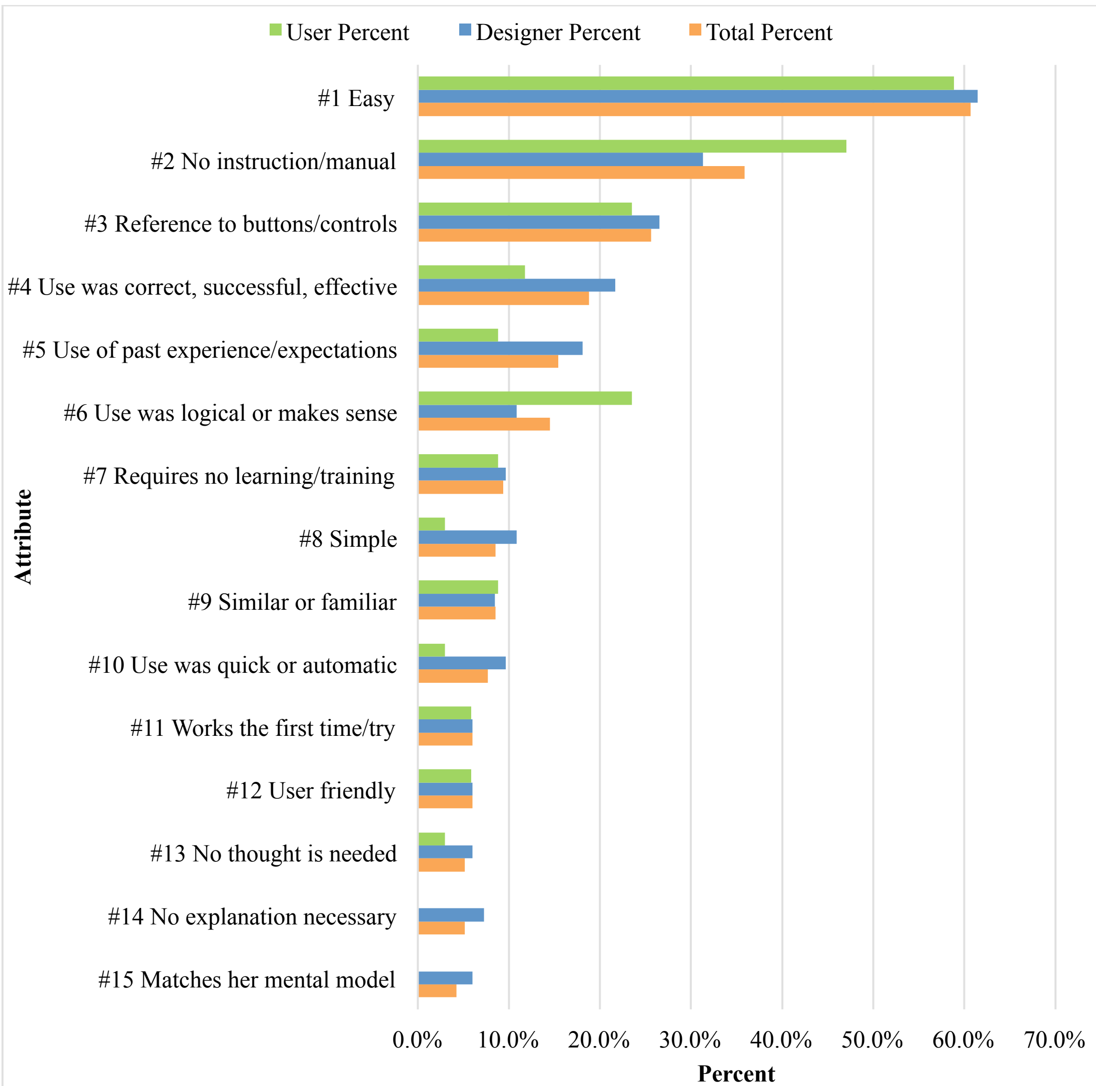


Figure 17 Top 15 Attributes of Open-ended Definitions Arranged by Total Percent for each Group. Note: Attributes are abbreviated from Table 14 to save space.

Table 15 shows the top 15 open-ended terms synonymous with intuitive use arranged by total percent. Out of 134 participants, 116 responded to the question regarding this attribute. From those responses, 33 were Users and 83 were Designers. A total of 50 attributes were identified in participants' responses. A complete table is included in Appendix C. The most frequently cited attributes observed for all participants were: Easy to use/understand/figure out (62.1%); Understandable, make sense, logical (31.9%); Simple (19.8%); Instinctual/inherent/innate (12.9%); and Natural (12.9%).

Table 15 Top 15 Open-ended Terms Synonymous with Intuitive Use Arranged by Total Percent

		Group					
#	Synonymous Term	User (Count out of 33)	User (%)	Designer (Count out of 83)	Designer (%)	Total (Count out of 116)	Total (%)
1	Easy to use/understand/figure out	19	57.6%	53	63.9%	72	62.1%
2	Understandable, make sense, logical	14	42.4%	23	27.7%	37	31.9%
3	Simple	3	9.1%	20	24.1%	23	19.8%
4	Instinctual/inherent/innate	6	18.2%	9	10.8%	15	12.9%
5	Natural	7	21.2%	8	9.6%	15	12.9%
6	User friendly	3	9.1%	11	13.3%	14	12.1%
7	Anticipate outcomes or work as expected	3	9.1%	10	12.0%	13	11.2%
8	Obvious	4	12.1%	9	10.8%	13	11.2%
9	Clear	1	3.0%	10	12.0%	11	9.5%
10	Straight forward	4	12.1%	7	8.4%	11	9.5%
11	Common/basic sense/knowledge	3	9.1%	7	8.4%	10	8.6%
12	Self-explanatory	2	6.1%	8	9.6%	10	8.6%
13	No instruction/direction needed	1	3.0%	6	7.2%	7	6.0%
14	Prior knowledge/previous experience	1	3.0%	5	6.0%	6	5.2%
15	No learning/training	1	3.0%	5	6.0%	6	5.2%

User and Designers had similar percentages for attributes #7, 8, 11, 14 and 15. However, there were notable differences between attributes #2, 3, 5, and 9. Attribute #2, *Understandable, make sense, logical,* was mentioned by 42.4% of Users compared to 27.7% of Designers. Attribute #3, *Simple,* was mentioned by 9.1% of Users compared to 24.1% of Designers. Attribute #5, *Natural,* was mentioned by 21.2% of Users compared to 9.6% of Designers. Attribute #9, *Clear,* was mentioned by 3.0% of Users compared to 12.0% of Designers. Figure 18 displays the data from Table 15 graphically, showing the top 15 attributes of open-ended synonymous terms arranged by total percent for each group.

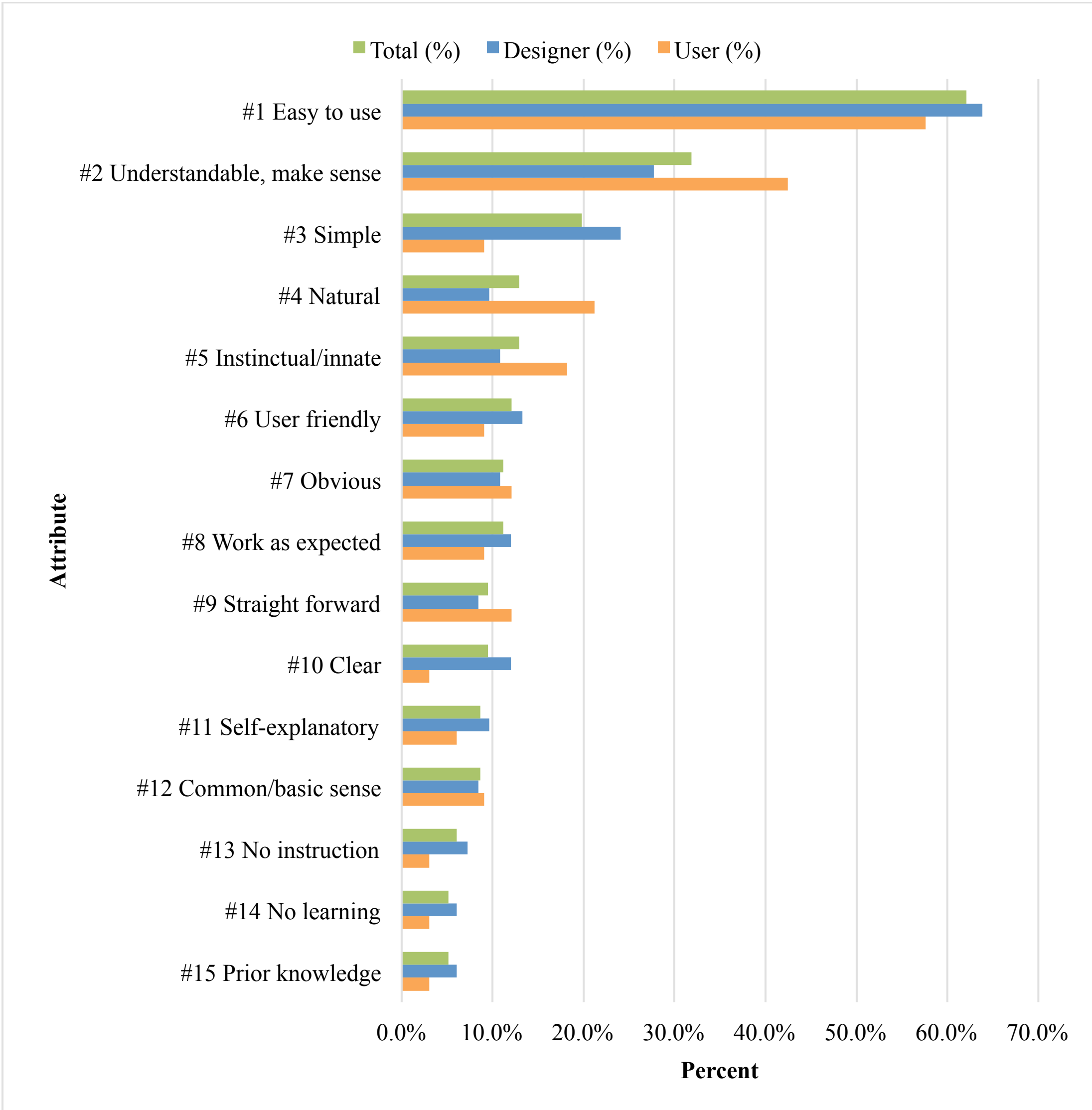


Figure 18 Top 15 Open-ended Synonymous Terms Arranged by Total Percent for each Group. Note: Attributes are abbreviated from Table 15 to save space.

4.2.3 Block 4 Results: Agreement with Literature Definition

The following shows results from Block 4: Agreement with the Literature Definition. Recall from Section 3.2.3.5, statements were written in a positive and negative way for balance. Figure 19 shows the survey Likert scale with level of agreement displayed below the double-headed arrow and coded values displayed above the double-headed arrow. The data in this section excludes *No Opinion* responses from descriptive statistics and statistical test.

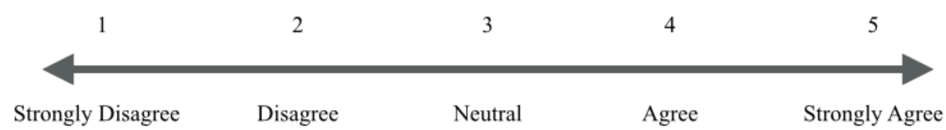


Figure 19 Survey Likert Scale with Level of Agreement Displayed Below and Coded Values Displayed Above. Note: No Opinion excluded

The results section contains box plots. Box plots graphically display information through quartiles. Figure 20 shows an annotated box and whisker plot. The median (2nd quartile) is the middle number of the data set when the numbers are arranged least to greatest. The 1st quartile is the median of the lower half of the data set when arranged from least to greatest and the 3rd quartile is the median of the upper half of the data set when arranged from least to greatest. This also means 50% of the data is between the 1st and 3rd quartile. Next, the whiskers represent a 95% confidence interval (CI) around the mean value for the data. Therefore, data points falling outside a 95% CI are considered outliers.

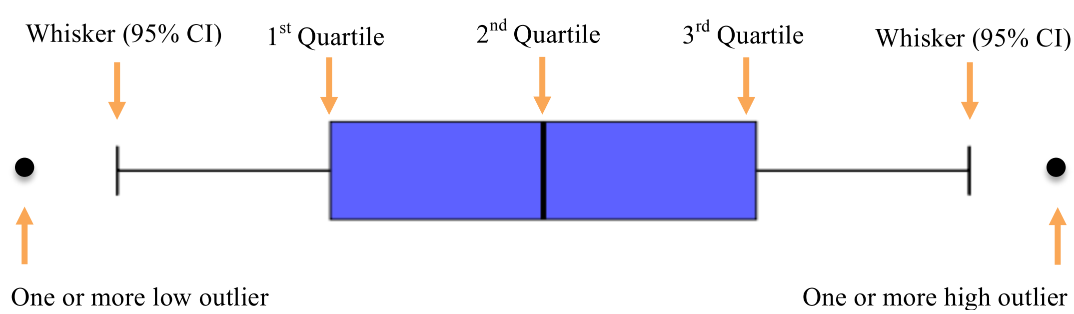


Figure 20 Annotated Box and Whisker Plot

Table 16 presents a summary of descriptive statistics for statements about intuitive use attributes. The table includes results for Users and Designers across the five attributes with the number of responses, n, minimum, maximum, mean, and standard deviation values.

Table 16 contains a column titled *Wording* to distinguish positive questions from negative questions. Positive questions are indicated with a "+" and negative questions are indicated with a "-". For example, "Sarah said her new microwave was intuitive to use because she could use it **subconsciously**" is a positive question because values greater than 3 show agreement with the final attribute, subconscious. Alternatively, "Sarah said her new microwave was intuitive to use because she **made errors** when using it" is a negative question because values smaller than 3 show agreement with the final attribute, results are effective. In summary, a heuristic that can be used is values greater than 3 with a positive question and values smaller than 3 with a negative question correspond to participants' agreement with the listed attribute. The heuristic was used to populate the last column, *Result*. Additional explanation about positive and negative question is included in Section 3.2.3.5 and 3.5.1. Box plots and percentage distributions for each attribute follow the summary table.

Table 16 Summary of Statistics for Statements about Intuitive Use Attributes. Note: Data excludes *No Opinion* responses. Raw Data is displayed, values were NOT converted.

	Summary of Statistics for Statements about Intuitive Use Attributes							
Group	Attribute	Wording	N	Minimum	Maximum	Mean	Std. Deviation	Result
Users	Subconscious	+	33	1	5	3.36	1.220	Agree
	Results are effective	-	34	1	4	1.56	.786	Agree
	Prior Knowledge	+	34	2	5	3.82	1.141	Agree
	Low mental effort	-	34	1	4	1.47	.748	Agree
	Results are satisfying	+	34	1	5	3.26	1.189	Agree
Designers	Subconscious	+	79	1	5	3.84	1.213	Agree
	Results are effective	-	83	1	4	1.41	.645	Agree
	Prior Knowledge	+	82	1	5	4.10	.924	Agree
	Low mental effort	-	83	1	5	1.51	.687	Agree
	Results are satisfying	+	82	1	5	3.45	1.056	Agree

4.2.3.1 Subconscious

Figure 21 presents Users' vs. Designers' responses for the attribute: Subconscious. Out of 134 participants, 112 responded to the question regarding this attribute. From those responses, 33 were Users and 79 were Designers. Users' responses had a median of 4 (average = 3.36) and Designers' responses had a median of 4 (average = 3.84). The whiskers show the CI ranged from one to five for Users and Designers. Users' responses fell mostly in the 1st quartile and Designers' responses were split fairly evenly between the 1st and 3rd quartiles. The standard deviations of both groups were similar (Users = 1.220, Designers = 1.213). There were no outliers present in the data.

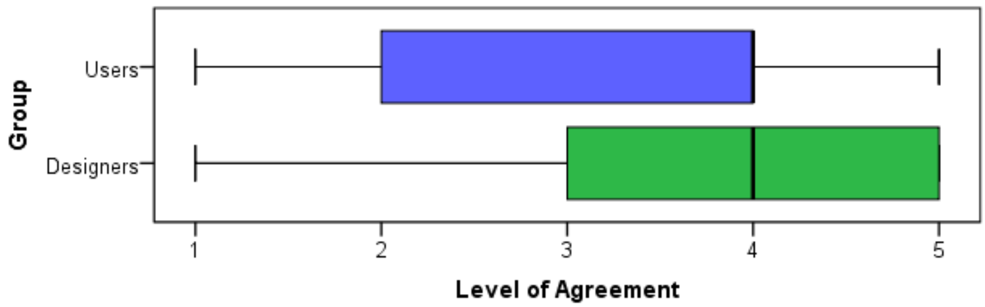


Figure 21 Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she could use it subconsciously" testing the Attribute: Subconscious (+).

Figure 22 shows the distribution of Users' vs. Designers' responses for the attribute: subconscious. *Agree* (50%) was the largest percentage of Users' responses. Whereas *Agree* (33.7%) and *Strongly Agree* (33.7%) were the largest percentages of Designers' responses. There was one *No Opinion* response from Users' and four from Designers'. Figure 21 and Figure 22 show that the Designers' distribution is left skewed. Results from a Chi-square test showed there was not a significant difference between the distributions of Users and Designers (χ^2 = 4.125, p = .127).

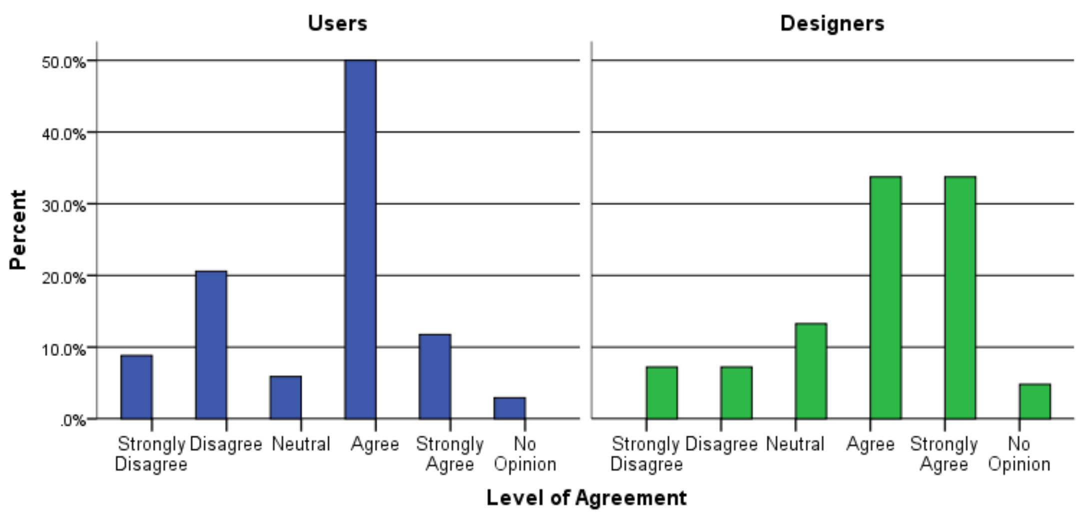


Figure 22 Distribution of Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she could use it subconsciously" testing the Attribute: Subconscious (+).

4.2.3.2 Results are Effective

Figure 23 presents Users' vs. Designers' responses for the attribute: Results are Effective. Out of 134 participants, 117 responded to the question regarding this attribute. From those responses, 34 were Users and 83 were Designers. Users' responses had a median of 1 (average = 1.56) and Designers' responses had a median of 1 (average = 1.41). The whiskers show the CI ranged from one to three for Users and Designers. Users' and Designers' responses fell mostly in-between the 2nd and 3rd quartiles. The standard deviations of both groups were similar (Users = .786, Designers = .645). There was one outlier present in each group.

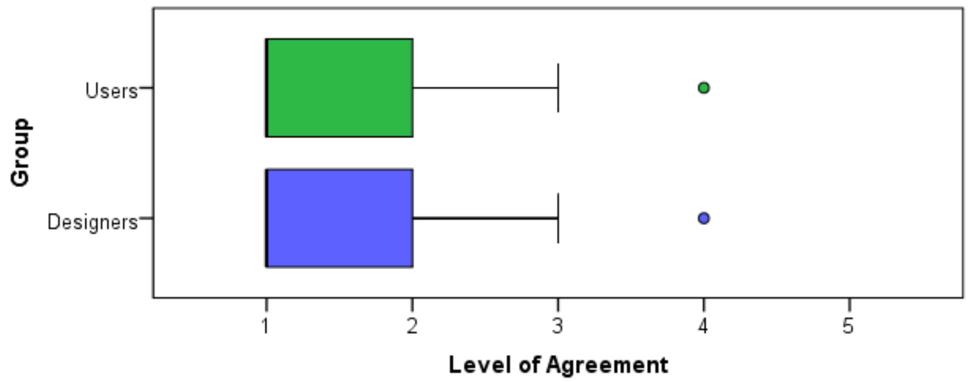


Figure 23 Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she made errors when using it" testing the Attribute: Results are Effective (-).

Figure 24 shows the distribution of Users' vs. Designers' responses for the attribute: Results are Effective. *Strongly disagree* was the largest percentage of Users' and Designers' responses, constituting 58.8% and 66.3%, respectively. Figure 23 and Figure 24 show that the Users' and Designers' distribution is right skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = 1.158, p = .560). Note: Assumption #7 (the value of the cell *expecteds* should be 5 or more, listed in Section 3.5.3) of the Chi-square test was violated even when categories were combined.

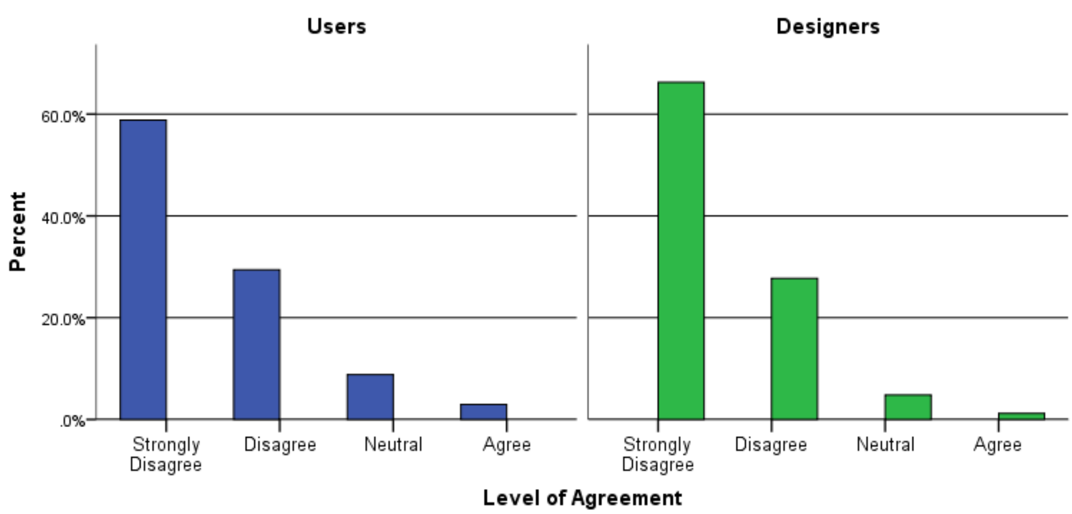


Figure 24 Distribution of Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she made errors when using it" testing the Attribute: Results are Effective (-).

4.2.3.3 Prior Knowledge

Figure 25 presents Users' vs. Designers' responses for the attribute: Prior Knowledge. Out of 134 participants, 116 responded to the question regarding this attribute. From those responses, 34 were Users and 82 were Designers. Users' responses had a median of 4 (average = 3.82) and Designers' responses had a median of 4 (average = 4.10). The whiskers show the CI ranged from two to five for Users and three to five for Designers. Users' responses were split fairly evenly between the 1st and 3rd quartiles and Designers' responses fell mostly in-between the 2nd and 3rd quartiles. The standard deviations of each group were different (Users = 1.141, Designers = .924). There were no outliers present for Users and six outliers were present for Designers.

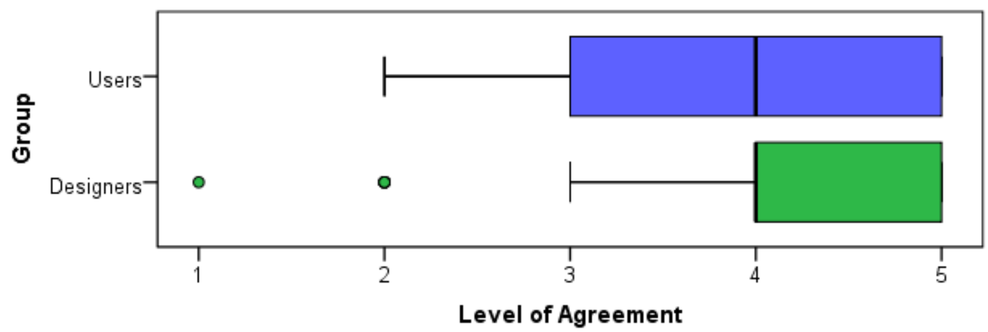


Figure 25 Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she could use prior knowledge from her old microwave" testing the Attribute: Prior Knowledge (+).

Figure 26 shows the distribution of Users' vs. Designers' responses for the attribute: Prior Knowledge. *Strongly Agree* (35.3%) and *Agree* (32.4%) were the largest percentages of Users' responses. Similarly, *Strongly Agree* (37.8%) and *Agree* (42.7%) were the largest percentages of Designers' responses. Figure 25 and Figure 26 show that the Designers' distribution is left skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = 4.297, p = .117). Note: Assumption seven of the Chi-square test was violated even when categories were combined.

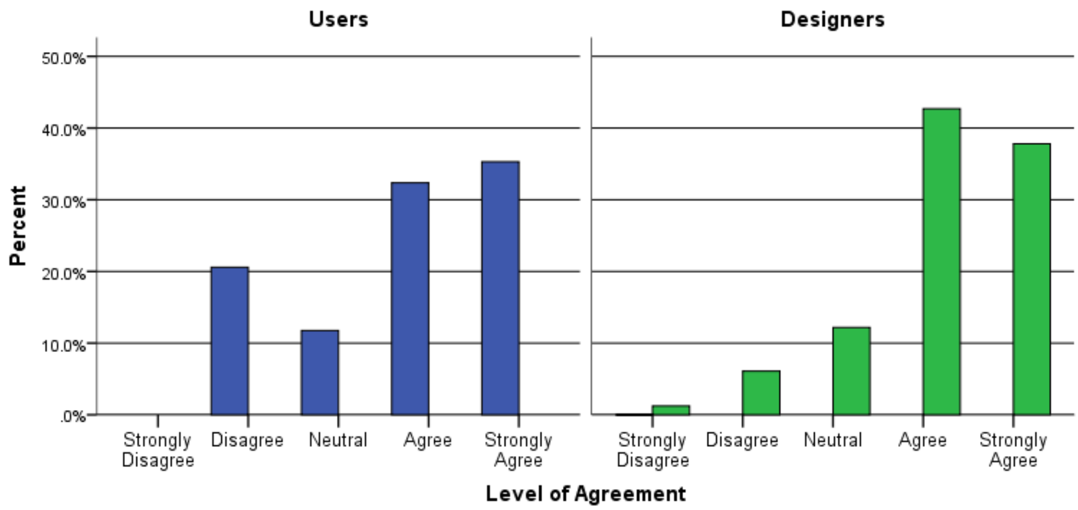


Figure 26 Distribution of Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she could use prior knowledge from her old microwave" testing the Attribute: Prior Knowledge (+).

4.2.3.4 Low Mental Effort

Figure 27 presents Users' vs. Designers' responses for the attribute: Low Mental Effort. Out of 134 participants, 117 responded to the question regarding this attribute. From those responses, 34 were Users and 83 were Designers. Users' responses had a median of 1 (average = 1.47) and Designers' responses had a median of 1 (average = 1.51). The whiskers show the CI ranged from one to three for Users and Designers. Users' and Designers' responses fell mostly in-between the 2nd and 3rd quartiles. The standard deviations of both groups were similar (Users = .748, Designers = .687). There was one outlier present in each group.

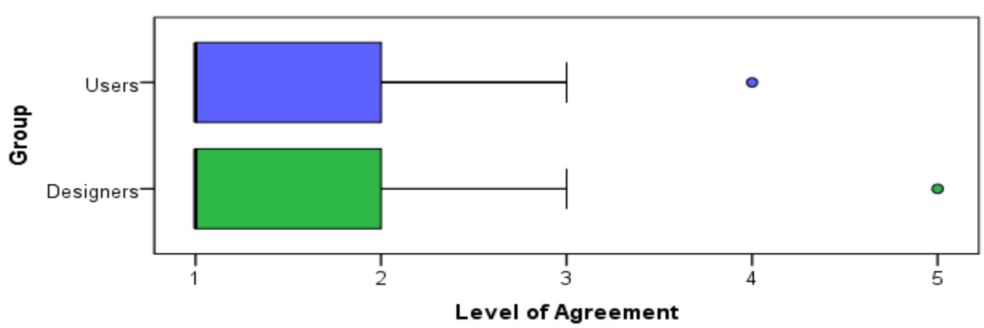


Figure 27 Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she thought deeply about how to make it do what she wanted" testing the Attribute: Low Mental Effort (-).

Figure 28 shows the distribution of Users' vs. Designers' Responses for the attribute: Low Mental Effort. *Strongly disagree* was the largest percentage of Users' and Designers' responses, constituting 64.7% and 56.6%, respectively. Figure 27 and Figure 28 show that the Users' and Designers' distributions are right skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = .757, p = .685). Note: Assumption seven of the Chi-square test was violated even when categories were combined.

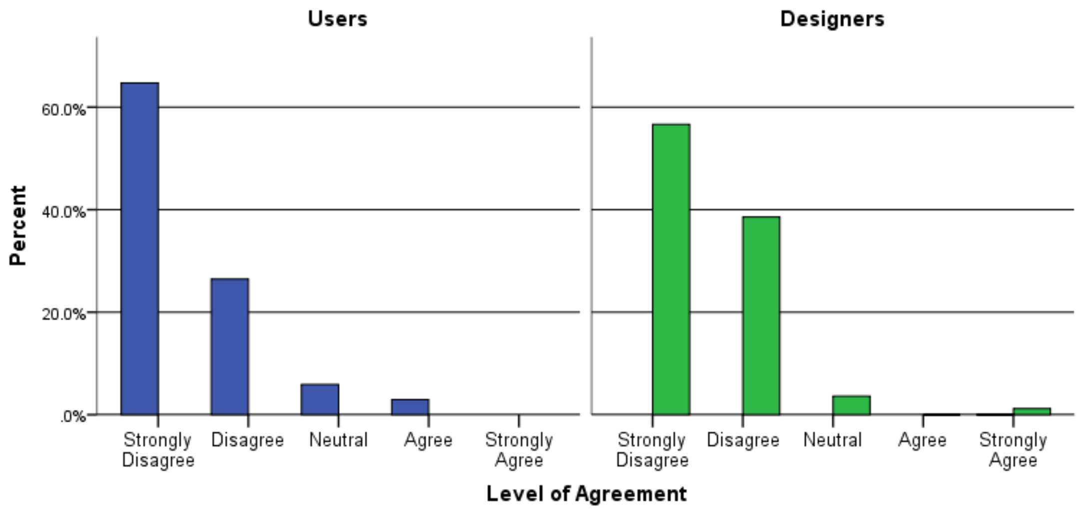


Figure 28 Distribution of Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because she thought deeply about how to make it do what she wanted" testing the Attribute: Low Mental Effort (-).

4.2.3.5 Results are Satisfying

Figure 29 presents Users' vs. Designers' responses for the attribute: Results are Satisfying. Out of 134 participants, 116 responded to the question regarding this attribute. From those responses, 34 were Users and 82 were Designers. Users' responses had a median of 3 (average = 3.26) and Designers' responses had a median of 4 (average = 3.45). The whiskers show the CI ranged from one to five for Users and two to five for Designers. Users' responses were split fairly evenly between the 1st and 3rd quartiles and Designers' responses fell mostly in-between the 1st and 2nd quartile. The standard deviations of each group were different (Users = 1.189, Designers = 1.056). There were three outliers present for Designers.

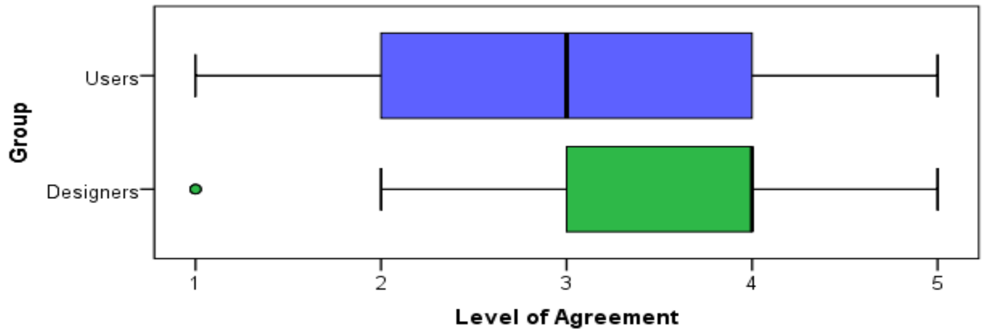


Figure 29 Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because it was satisfying to operate" testing the Attribute: Results are Satisfying (+).

Figure 30 shows the distribution of Users' vs. Designers' responses for the attribute: Results are Satisfying. *Neutral* (26.5%) and *Agree* (26.5%) were the largest percentages of Users' responses. *Agree* (40.2%) was the largest percentage of Designers' responses. There was one *No Opinion* response from Designers'. Figure 29 and Figure 30 show that the Designers' distribution is left skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = 1.358, p = .507).

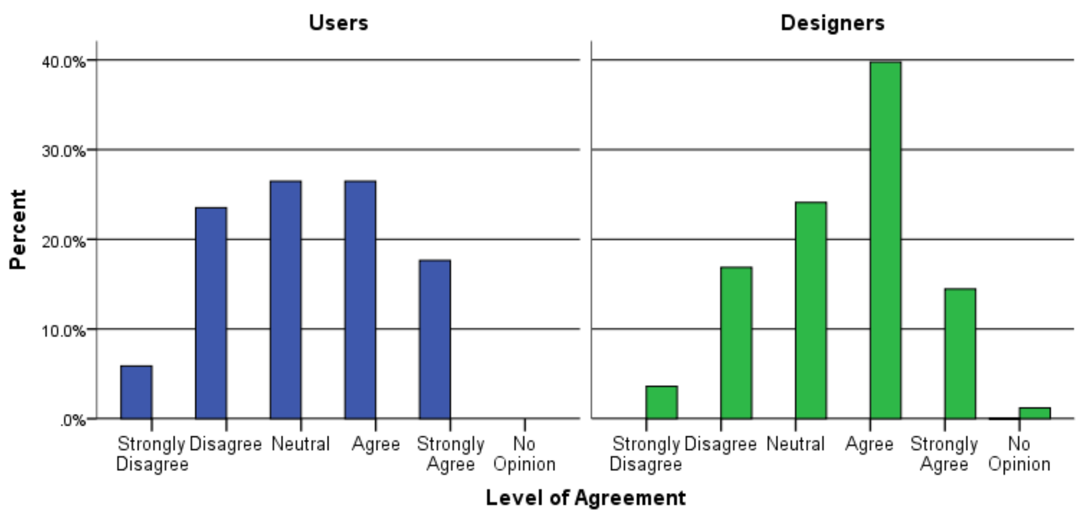


Figure 30 Distribution of Users' vs. Designers' Responses for "Sarah said her new microwave was intuitive to use because it was satisfying to operate" testing the Attribute: Results are Satisfying (+).

4.2.4 Block 5 Results: Intuitive Use versus Usability

The following shows results from Block 5: Intuitive Use versus Usability. Table 17 presents a summary of descriptive statistics for statements about intuitive use vs. usability. The table includes results for Users and Designers across the three attributes with the number of responses, n, minimum, maximum, mean, and standard deviation values. The data in this section excludes *No Opinion* responses from descriptive statistics and statistical tests. The summary table is followed by box plots and percent distributions for each attribute.

Recall from Section 3.2.3.6, statements were written to determine if participants could distinguish the three attributes that separate intuitive use from usability. Results of values greater than three correspond to intuitive use despite the mentioned attribute, meaning that the mentioned attribute is not a requirement for intuitive use. Alternatively, results of values smaller than three correspond to an intuitive use that is affected by the mentioned attribute, meaning that the mentioned attribute is important for an intuitive use. Each attribute will be discussed in detail following Table 17.

Table 17 Summary of Statistics for Statements about Intuitive Use vs. Usability

Summary of Statistics for Statements about Intuitive Use vs. Usability						
Group		N	Minimum	Maximum	Mean	Std. Deviation
Users	Users' physical effort	34	2	5	3.85	.989
	Time	33	1	5	3.27	1.180
	Cost ($)	34	2	5	4.38	.853
Designers	Users' physical effort	82	1	5	3.32	1.153
	Time	82	1	5	3.18	1.198
	Cost ($)	82	1	5	4.06	1.148

4.2.4.1 Users' Physical Effort

Figure 31 presents Users' vs. Designers' responses for the attribute: Users' Physical Effort. *Users' Physical Effort* is not related to the Users' vs. Designers' distinction considered in this study. This is simply another attribute presented by Hurtienne (2011). Out of 134 participants, 116 responded to the question regarding this attribute. From those responses, 34 were Users and 82 were Designers. Users' responses had a median of 4 (average = 3.85) and Designers' responses had a median of 4 (average = 3.32). The whiskers show the CI ranged from two to five for Users and one to five for Designers. Users' responses were split fairly evenly between the 1st and 3rd quartiles and Designers' responses fell mostly in-between the 1st and 2nd quartiles. The standard deviations of each group were different (Users = .989, Designers = 1.153). There were no outliers present in the data.

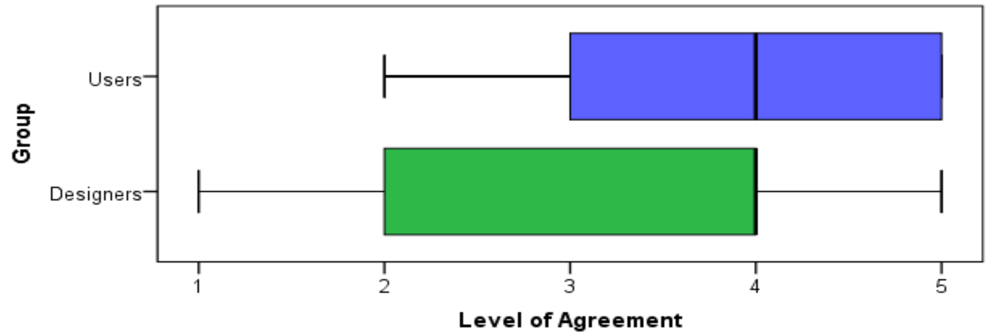


Figure 31 Users' vs. Designers' Responses for "Sarah's new microwave can be intuitive to use regardless of the physical effort it takes to operate" testing the Attribute: Users' Physical Effort

Figure 32 shows the distribution of Users' vs. Designers' responses for the attribute: Users' Physical Effort. *Agree* (47.1%) was the largest percentage of Users' responses. *Disagree* (29.3%) and *Agree* (39.0%) were the largest percentages of Designers' responses. There was one *No Opinion* response from Designers'. Figure 31 and Figure 32 show that the Users' and Designers' distributions are slightly left skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers ($\chi^2 = 4.539$, $p = .103$).

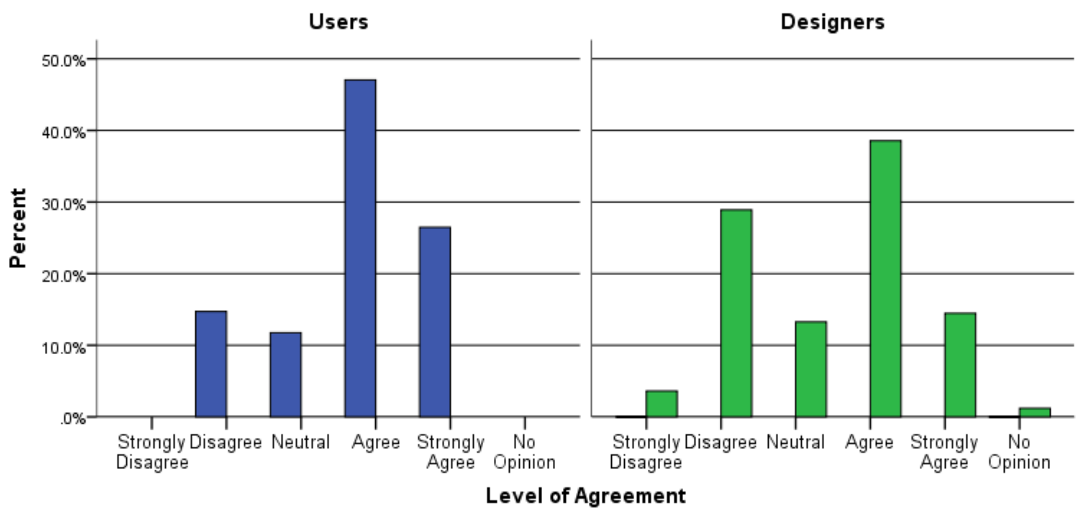


Figure 32 Distribution of Users' vs. Designers' Responses for "Sarah's new microwave can be intuitive to use regardless of the physical effort it takes to operate" testing the Attribute: Users' Physical Effort

4.2.4.2 Time

Figure 33 presents Users' vs. Designers' responses for the attribute: Time. Out of 134 participants, 115 responded to the question regarding this attribute. From those responses, 33 were Users and 82 were Designers. Users' responses had a median of 4 (average = 3.27) and Designers' responses had a median of 3.5 (average = 3.18). The whiskers show the CI ranged from one to five for Users and Designers. Users' responses fell mostly in-between the 1st and 2nd quartiles and Designers' responses were split between the 1st and 3rd quartiles. The standard deviations of both groups were similar (Users = 1.180, Designers = 1.198). There were no outliers present in the data.

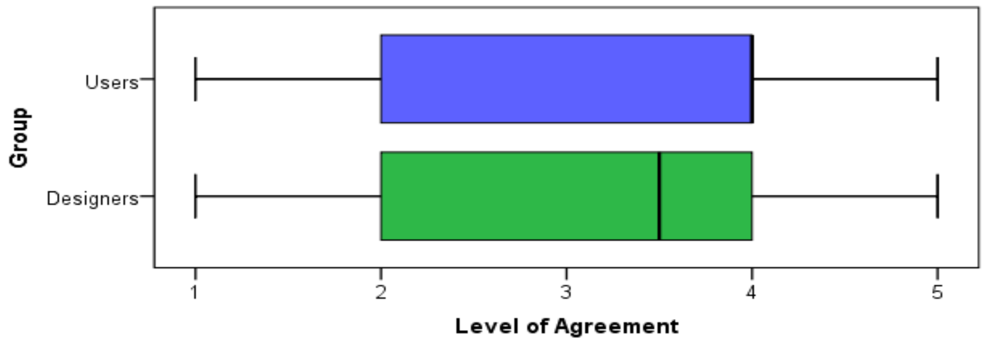


Figure 33 Users' vs. Designers' Responses for "Sarah's new microwave can be intuitive to use regardless of the time it takes to operate" testing the Attribute: Time

Figure 34 shows the distribution of Users' vs. Designers' responses for the attribute: Time. *Disagree* (33.3%) and *Agree* (36.4%) were the largest percentages of Users' responses. *Disagree* (35.4%) and *Agree* (36.6%) were the largest percentages of Designers' responses. There was one *No Opinion* response from Designers. Figure 33 and Figure 34 show that the Users' and Designers' distributions are not notably skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = .227, p = .893).

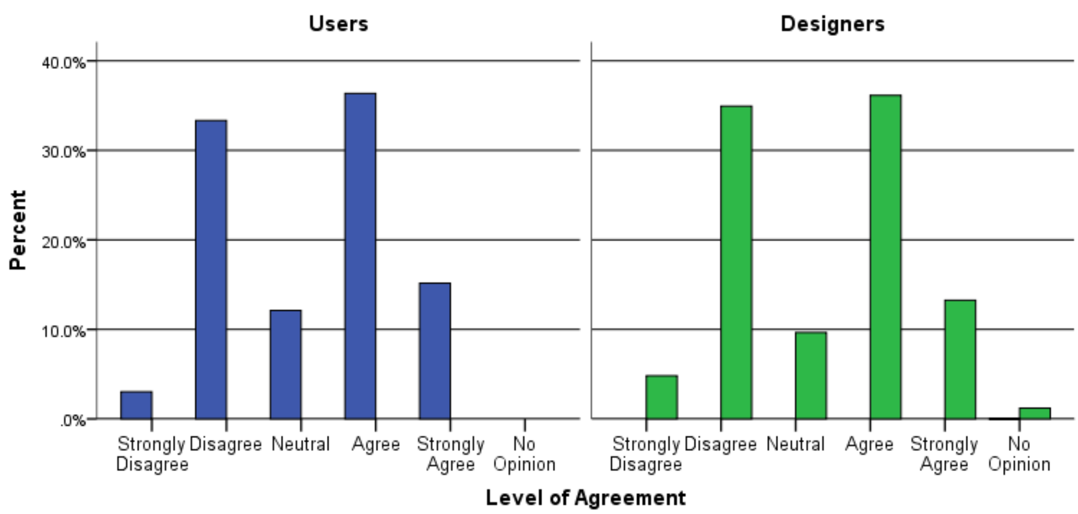


Figure 34 Distribution of Users' vs. Designers' Responses for "Sarah's new microwave can be intuitive to use regardless of the time it takes to operate" testing the Attribute: Time

4.2.4.3 Cost ($)

Figure 35 presents Users' vs. Designers' responses for the attribute: Cost ($). Out of 134 participants, 116 responded to the question regarding this attribute. From those responses, 34 were Users and 82 were Designers. Users' responses had a median of 5 (average = 4.38) and Designers' responses had a median of 4 (average = 4.06). The whiskers show thee CI ranged from three to five for Users and Designers. Users' responses fell mostly in-between the 1st and 2nd quartiles and Designers' responses fell mostly in-between the 2nd and 3rd quartile. The standard deviations of each group were different (Users = .853, Designers = 1.148). There were two outliers present for Users and 11 outliers present for Designers.

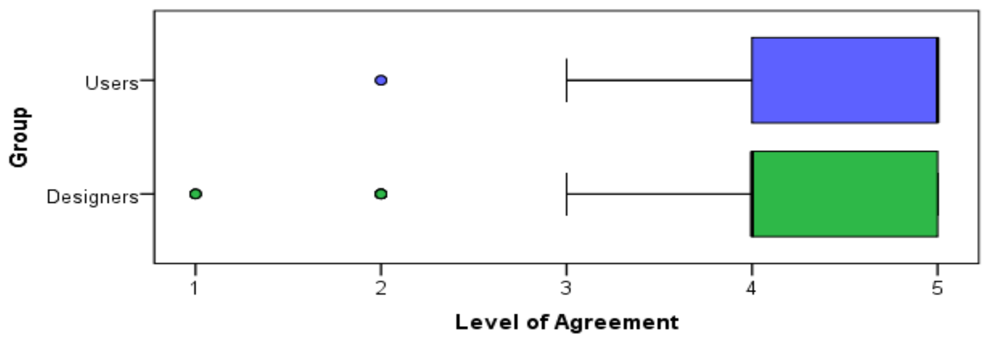


Figure 35 Users' vs. Designers' Responses for "Sarah's new microwave can be intuitive to use regardless of its cost ($)" testing the Attribute: Cost ($)

Figure 36 shows the distribution of Users' vs. Designers' responses for the attribute: Cost ($). *Agree* (32.4%) and *Strongly Agree* (55.9%) were the largest percentages of Users' responses. *Agree* (34.1%) and *Strongly Agree* (45.1%) were the largest percentages of Designers' responses. There was one *No Opinion* response from Designers'. Figure 35 and Figure 36 show that the Users' and Designers' distributions are slewed left. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = 1.524, p = .467). Note: Assumption seven of the Chi-square test was violated even when categories were combined.

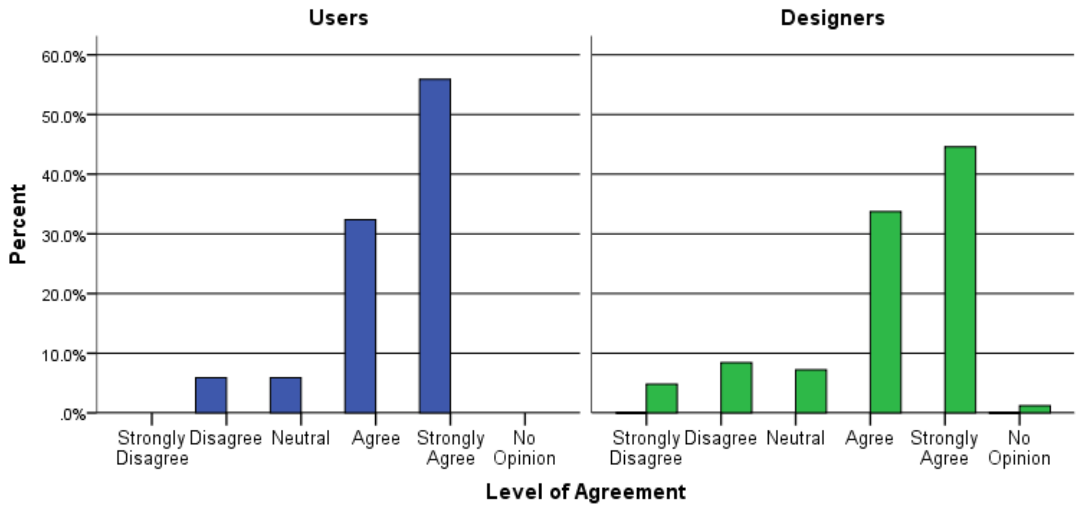


Figure 36 Distribution of Users' vs. Designers' Responses for "Sarah's new microwave can be intuitive to use regardless of its cost ($)" testing the Attribute: Cost ($)

4.2.5 Block 6 Results: Other Attributes

The following shows results from Block 6: Other Attributes. Table 18 presents a summary of descriptive statistics for statements about other attributes. The table includes results for Users and Designers across the six attributes with the number of responses, n, minimum, maximum, mean, and standard deviation values. The data in this section excludes *No Opinion* responses from descriptive statistics and statistical tests. The summary table is followed by box plots and percent distributions for each attribute.

Recall from Section 3.2.3.7, statements were written to potentially uncover other attributes of products or interfaces that may affect one's perception of intuitive use. All questions were written in a positive way. Participants responded to the statement, "The following affect how intuitive Sarah's microwave is to use" with regard to each attribute. Results of values greater than three correspond to perceptions that an attribute affects intuitive use. Alternatively, results of values smaller than three correspond to perceptions that an attribute does not affect intuitive use. Each attribute will be discussed in detail following Table 18.

Table 18 Summary of Statistics for Statements about Other Attributes

Summary of Statistics for Statements about Other Attributes						
Group		N	Minimum	Maximum	Mean	Std. Deviation
Users	Safety	32	1	5	2.59	1.073
	Aesthetics	32	1	5	3.22	1.237
	Level of complexity	32	4	5	4.78	.420
	Physical size	32	1	4	2.38	1.070
	Mood	33	1	5	3.09	1.156
	Similarity	31	2	5	4.19	.703
Designers	Safety	82	1	5	2.82	1.079
	Aesthetics	82	1	5	3.48	1.178
	Level of complexity	82	2	5	4.67	.589
	Physical size	81	1	5	2.44	1.151
	Mood	80	1	5	3.26	1.145
	Similarity	82	1	5	4.05	.942

4.2.5.1 Safety

Figure 37 presents Users' vs. Designers' responses for the attribute: Safety. Out of 134 participants, 114 responded to the question regarding this attribute. From those responses, 32 were Users and 82 were Designers. Users' responses had a median of 2.5 (average = 2.59) and Designers' responses had a median of 3 (average = 2.82). The whiskers show the CI ranged from one to four for Users and one to five for Designers. Users' and Designers' responses were observed mostly in-between the 1st and 3rd quartiles. The standard deviations of both groups were similar (Users = 1.073, Designers = 1.079). There was one outlier present for Users and no outliers present for Designers.

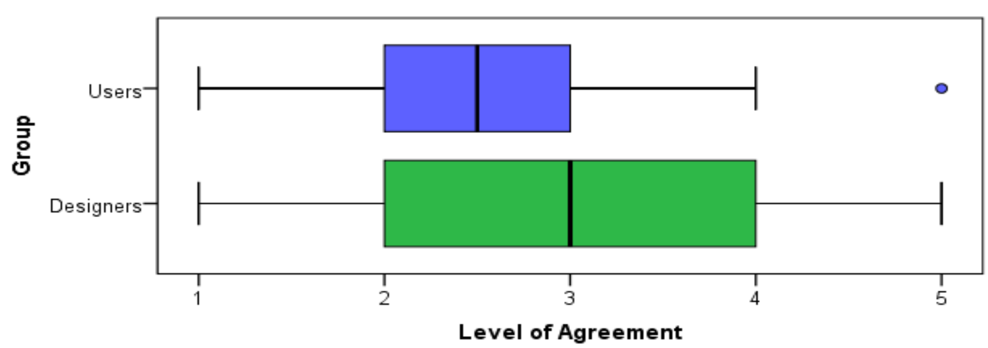


Figure 37 Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Safety

Figure 38 shows the distribution of Users' vs. Designers' responses for the attribute: Safety. Dis*agree* (34.4%) and *Neutral* (28.1%) were the largest percentages of Users' responses. Dis*agree* (25.6%) and *Neutral* (36.6%) were the largest percentages of Designers' responses. There was one *No*

Opinion response from Users'. Figure 37 and Figure 38 show that the Users' and Designers' distributions are slightly slewed right. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = 1.443, p = .486).

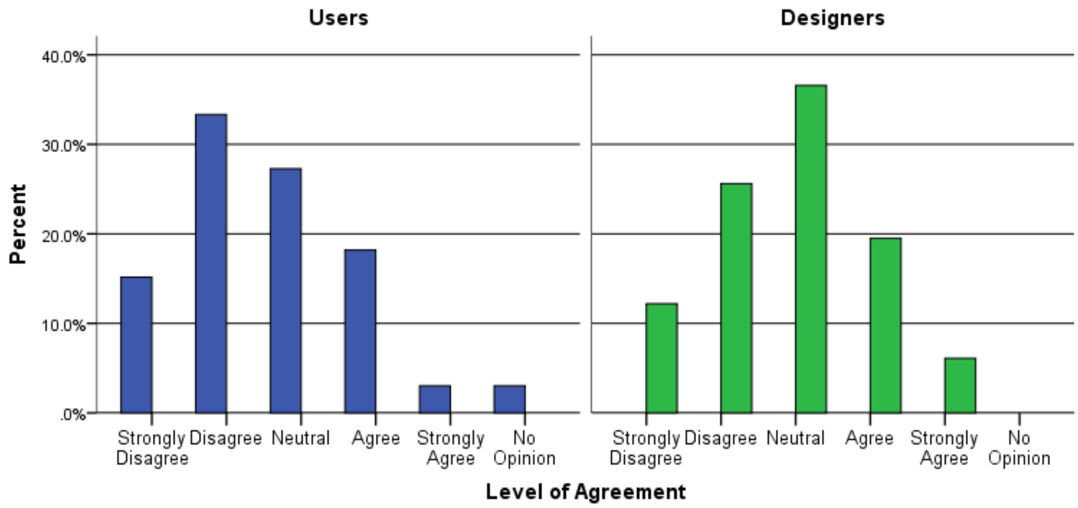


Figure 38 Distribution of Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Safety

4.2.5.2 Aesthetics

Figure 37 presents Users' vs. Designers' responses for the attribute: Aesthetics. Out of 134 participants, 114 responded to the question regarding this attribute. From those responses, 32 were Users and 82 were Designers. Users' responses had a median of 4 (average = 3.22) and Designers' responses had a median of 4 (average = 3.48). The whiskers show the CI ranged from one to five for Users and two to five for Designers. Users' and Designers' responses were observed mostly in-between the 1st and 2nd quartiles. The standard deviations of both groups were similar (Users = 1.237, Designers = 1.178). There were no outliers present for Users and seven outliers present for Designers.

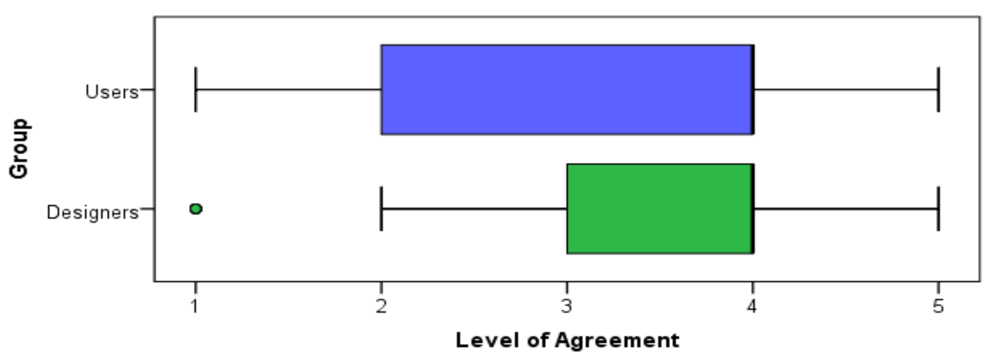


Figure 39 Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Aesthetics

Figure 40 shows the distribution of Users' vs. Designers' responses for the attribute: Aesthetics. *Agree* (40.6%) was the largest percentage of Users' responses. *Agree* (43.9%) was the largest percentage of Designers' responses. There was one *No Opinion* response from Users'. Figure 39 and Figure 40 show that the Users' and Designers' distributions are slewed left. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = 1.943, p = .379).

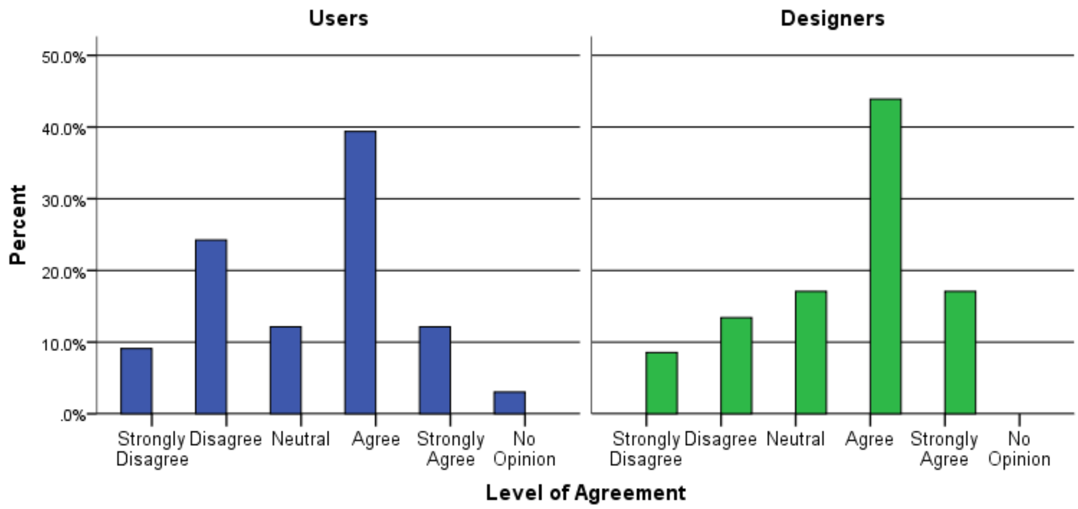


Figure 40 Distribution of Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Aesthetics

4.2.5.3 Level of Complexity

Figure 41 presents Users' vs. Designers' responses for the attribute: Level of Complexity. Out of 134 participants, 114 responded to the question regarding this attribute. From those responses, 32 were Users and 82 were Designers. Users' responses had a median of 5 (average = 4.78) and Designers' responses had a median of 5 (average = 4.67). The whiskers show the CI did not deviate from five for Users. Designers' CI ranged from three to five. Users' responses are obscured given the response data and Designers' responses were observed mostly in-between the 1st and 2nd quartiles. The standard deviations of both groups were similar (Users = .420, Designers = .589). There were seven outliers present for Users and one outlier present for Designers.

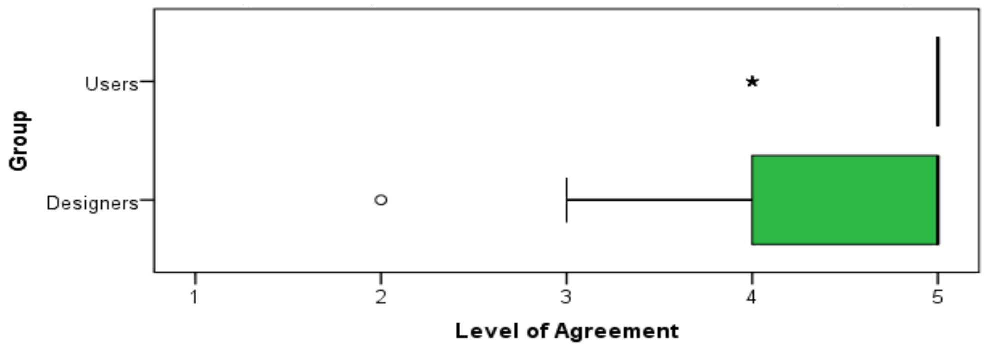


Figure 41 Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Level of Complexity

Figure 42 shows the distribution of Users' vs. Designers' responses for the attribute: Level of Complexity. *Strongly Agree* (78.1%) was the largest percentage of Users' responses. *Strongly Agree* (72.0%) was the largest percentage of Designers' responses. There was one *No Opinion* response from Users'. Figure 41 and Figure 42 show that the Users' and Designers' distributions are heavily left skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers ($\chi^2 = 1.202$, p = .548). Note: Assumption seven of the Chi-square test was violated even when categories were combined.

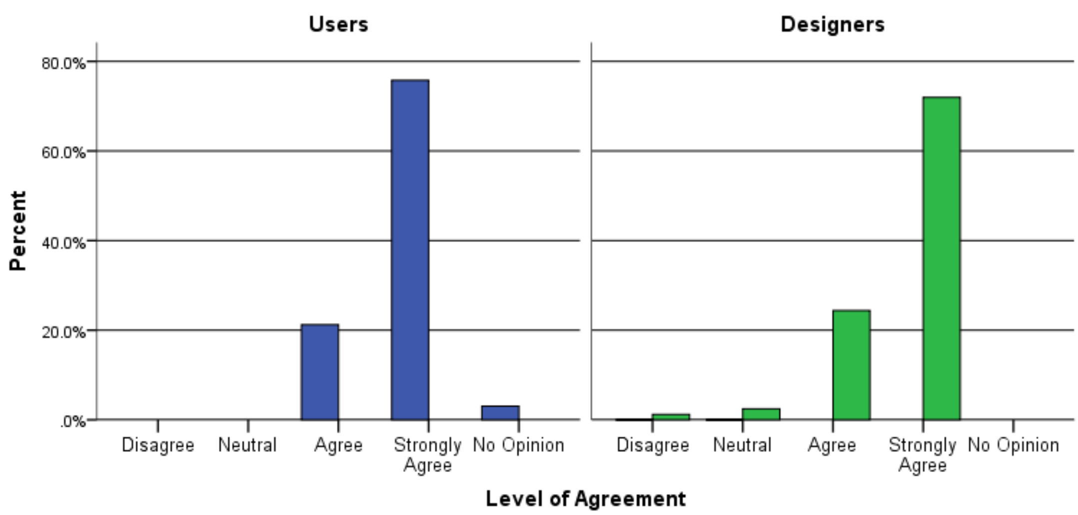


Figure 42 Distribution of Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Level of Complexity

4.2.5.4 Physical Size

Figure 43 presents Users' vs. Designers' responses for the attribute: Physical Size. Out of 134 participants, 113 responded to the question regarding this attribute. From those responses, 32 were Users and 81 were Designers. Users' responses had a median of 2 (average = 2.38) and Designers' responses had a median of 2 (average = 2.44). The whiskers show the CI ranged from one to five for both groups. Users' and Designers' responses were observed mostly in-between the 2nd and 3rd quartiles. The standard deviations of both groups were similar (Users = 1.070, Designers = 1.151). There were no outliers present for Users and seven outlier present for Designers.

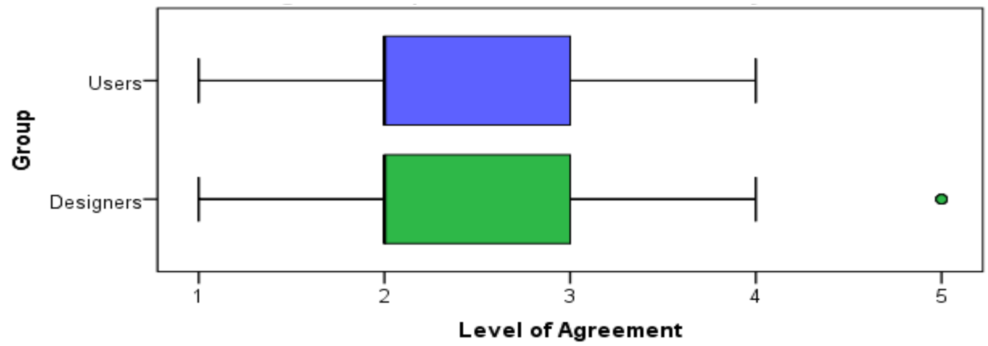


Figure 43 Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Physical Size

Figure 44 shows the distribution of Users' vs. Designers' responses for the attribute: Physical Size. *Disagree* was the largest percentage of Users' and Designers' responses, 40.6% and 33.3%, respectively. There was one *No Opinion* response from Users' and one from Designers'. Figure 43 and Figure 44 show that the Users' and Designers' distributions are right skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = .841, p = .657).

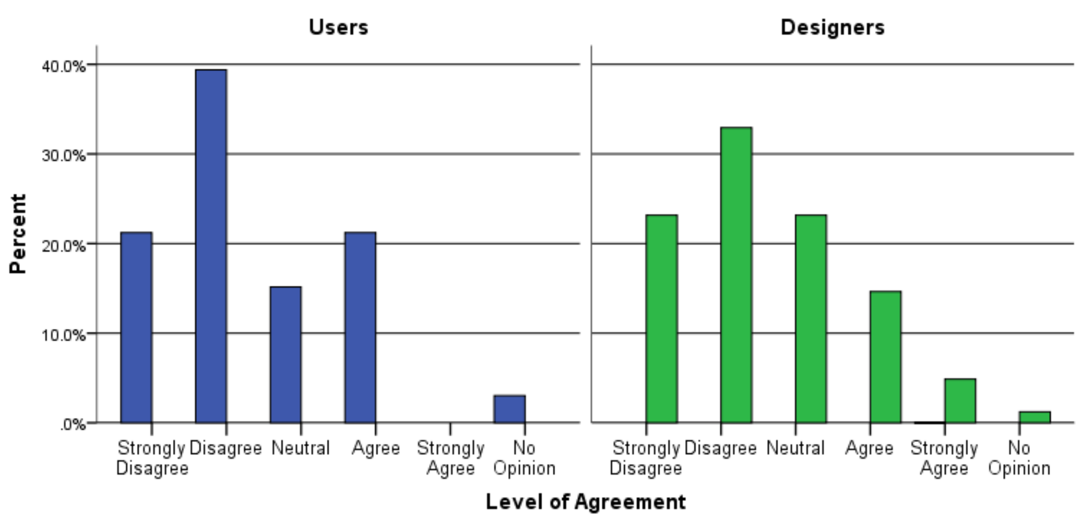


Figure 44 Distribution of Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Physical Size

4.2.5.5 Mood

Figure 45 presents Users' vs. Designers' responses for the attribute: Mood. Out of 134 participants, 113 responded to the question regarding this attribute. From those responses, 31 were Users and 80 were Designers. Users' responses had a median of 3 (average = 3.09) and Designers' responses had a median of 3.5 (average = 3.26). The whiskers show the CI ranged from one to five for both groups. Users' and Designers' responses were observed mostly in-between the 1st and 3rd quartiles. The standard deviations of both groups were similar (Users = 1.156, Designers = 1.145). There were no outliers present for either group.

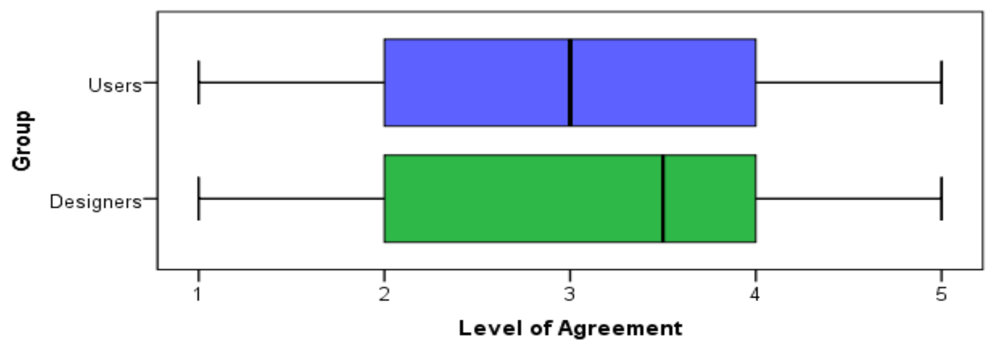


Figure 45 Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Mood

Figure 46 shows the distribution of Users' vs. Designers' responses for the attribute: Mood. *Agree* was the largest percentage of Users' and Designers' responses, 39.4% and 38.8%, respectively. There were two *No Opinion* response from Designers'. Figure 45 and Figure 46 shows the Users' and Designers' distributions are left skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = .241, p = .886).

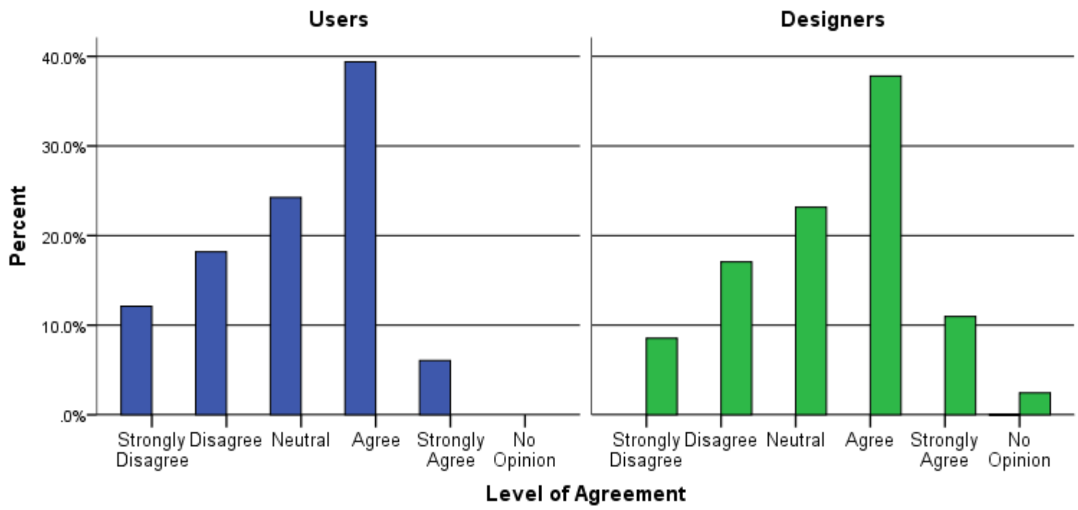


Figure 46 Distribution of Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Mood

4.2.5.6 Similarity

Figure 47 presents Users' vs. Designers' responses for the attribute: Similarity. Out of 134 participants, 113 responded to the question regarding this attribute. From those responses, 31 were Users and 82 were Designers. Users' responses had a median of 4 (average = 4.19) and Designers' responses had a median of 4 (average = 4.05). The whiskers show the CI ranged from three to five for both groups. Users' and Designers' responses were observed mostly in-between the 2nd and 3rd quartiles. The standard deviations of both groups were similar (Users = .703, Designers = .942). There was one outlier present for Users and nine for Designers.

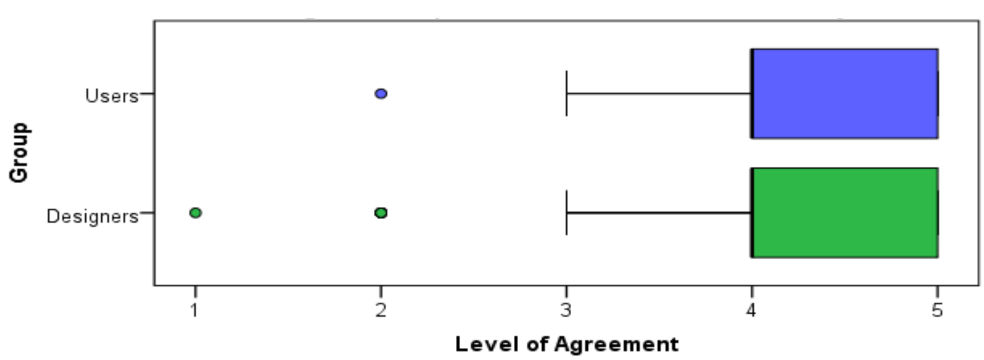


Figure 47 Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Similarity

Figure 48 shows the distribution of Users' vs. Designers' responses for the attribute: Similarity. *Agree* was the largest percentage of Users' and Designers' responses, 58.1% and 51.2%, respectively. There were two *No Opinion* response from Users'. Figure 47 and Figure 48 shows the Users' and

Designers' distributions are heavily left skewed. Results from a Chi-square test show there was not a significant difference between the distributions of Users and Designers (χ^2 = .1732, p = .421). Note: Assumption seven of the Chi-square test was violated even when categories were combined.

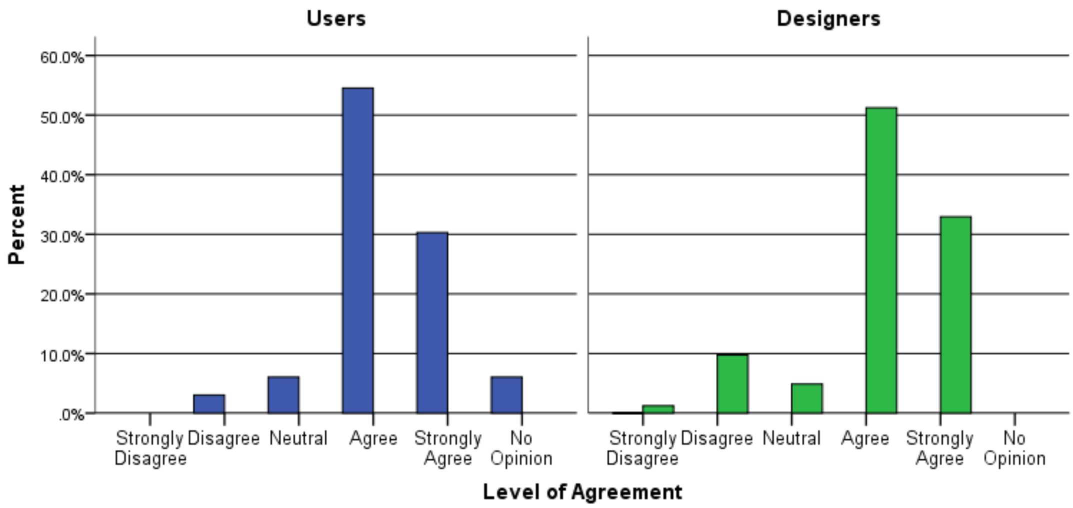


Figure 48 Distribution of Users' vs. Designers' Responses for "The following affect how intuitive Sarah's microwave is to use" testing the Attribute: Similarity

4.2.6 Block 7 Results: Other Attributes: Open-ended Responses

4.2.6.1 Introduction

As described in the Methodology chapter, the open-ended questions for each attribute were only presented to participants who responded *Strongly Agree*. The following presents a summary of responses for each attribute.

4.2.6.2 Safety

Out of 6 participants who responded *Strongly Agree*, 5 answered the open-ended question regarding this attribute. From those responses, there was 1 User and 4 Designers. Users' and Designers' responses did not deviate in the open-ended responses; therefore they will be described together.

Safety related to a positive experience with the microwave. Participants said unsafe products are harder to operate and result in more time spent learning. Participants also related microwave features to safety, for example, "It may be programmed to take into consideration certain safety hazards". Participants felt safety is an expected feature built into a product and results in a feeling of ease.

4.2.6.3 Aesthetics

Out of 18 participants who responded *Strongly Agree*, 16 answered the open-ended question regarding this attribute. From those responses, there were 4 Users and 12 Designers. Users' and Designers' responses focused on different topics, therefore they will be described separately.

Designers related appearance and presentation to intuitive use. For example, "How the buttons are labeled, shaped, colored, or highlighted all can contribute to a more intuitive design". They also mentioned that population stereotypes like direction of reading (top to bottom, left to right) and industry standards for colors and symbols (red means stop). Developers also mentioned that aesthetics lead to emotions that reduce operator frustration. For example, "aesthetics will greatly affect how intuitive you believe something to be [...] if the controls and buttons look 'easy to understand' what their function is, then that interface will be more intuitive." Additionally, Designers recommended support or help mechanisms like icons or videos to make the microwave more "intuitive". A good summary provided by a Designer was, "The layout of the controls is a key factor, e.g. location, ease of operability (push button, alarms, levers, readouts, markings, etc). So when you look at a product, if it quickly makes sense based on prior knowledge and abilities, then ones intuition will quickly lead to an understanding of how to operate the microwave effectively."

Users related aesthetics to form and function. They felt the visual design should be apparent so that instructions do not need to be read. Users said the way we interact with machines is shaped by the aesthetics of the interface. Users are concerned with interfaces that set the proper expectations for the experience. For example, "does it have large buttons that are easy to read, is the text clear, are there many 'hidden functions' that I have to memorize? Aesthetics helps the machine be approachable and often can influence the level of complexity I expect".

4.2.6.4 Level of Complexity

Out of 84 participants who responded *Strongly Agree*, 79 answered the open-ended question regarding this attribute. From those responses, there were 25 Users and 54 Designers. Users' and Designers' responses focused on different topics, therefore they will be described separately.

Some Designers said complexity is not inherently intuitive, and therefore instructions are needed. Instructions lead to learning and training, which does not corresponding to intuitive use. They also said complexity requires problem solving. Several Designers made the relationship, "As level of complexity goes up, intuitiveness frequently goes down". Complexity was related to a longer task completion time, which translated into non-intuitive use. Additionally, Designers related a greater number of steps or more complex steps with a less intuitive use.

Conversely, some Designers said processes can be complex yet intuitive. For example, some functions and buttons can be very simple and intuitive, however the physics and mechanics may be complex or other operations can be more complex if used. This related to distinguishing actual complexity versus perceived complexity. For example, "The perceived level of complexity will affect the judgment of intuitiveness". In this situation the actual complexity and perceived complexity may be different, but it still influences the operators use. Some Designers talked about complex systems where intuitive use may be justifiably sacrificed. For example, "highly complex systems can be more intuitive than not, but intuitiveness may necessarily have to drop off in order to ensure zero-tolerance for bad outcomes".

Users made the same parallel as Designers between complexity and the use of instructions. For example, "To be intuitive, something must be able to be used without instructions, just based on prior knowledge. You would not usually be able to use something complex just based on intuition alone". Here complexity was linked with a need to read the instructions. Users also paralleled level of complexity with the number of steps needed to accomplish a task; many steps result in a complex process and lead to mistakes and the need for instructions. Another parallel was the relationship between complexity and intuitive use. For example, "The more complex, the less intuitive" agreed with Designers' responses. Some Users said if the level of complexity was "within the operator's current knowledge base" then it can be intuitive to use. Users also said more complex functions could distract from the root function of the product and make it more difficult to use.

4.2.6.5 Physical Size

Out of 4 participants who responded *Strongly Agree*, 3 answered the open-ended question regarding this attribute. From those responses, there were no Users and 3 Designers. Designers' responses did not seem to relate to the topic of intuitive use. Designers said microwave size varies to accommodate different contained spaces. One Designer said size should not be an issue if the microwave is easy to operate, despite indicating *Strongly Agree* to physical size affecting intuitive use.

4.2.6.6 Mood

Out of 11 participants who responded *Strongly Agree*, 9 answered the open-ended question regarding this attribute. From those responses, there was 1 User and 8 Designers. Users' and Designers' responses did not deviate in the open-ended responses; therefore they will be described together. Participants stated a person's mood affects their personal judgments and perceptions. For example, "If Sarah is in a terrible mood, then she may not have a good review of anything in the kitchen […] Even if the microwave is intuitive, she will not perceive it as such" and "She may be more prone to having negative thoughts which would change her perception of the microwave" In summary, participants said mood influences perceptions and behaviors that effect operators evaluation of intuitive use.

4.2.6.7 Similarity

Out of 37 participants who responded *Strongly Agree*, 35 answered the open-ended question regarding this attribute. From those responses, there were 10 Users and 25 Designers. Users' and Designers' responses focused on different topics; therefore they will be described separately.

Designers overwhelmingly agreed that using a microwave similar to her previous microwave meant she could use skills and prior knowledge she developed, meaning that she did not have to learn new skills. For example, "How intuitive something is depends on the prior knowledge of each person, so Sarah's previous microwave is part of her prior knowledge" and "Past experience seems to me to be a key factor in ease of use. If the keys are laid out the same as the old one, she probably didn't need to think about it at all to reheat food. She just touched the keys she needed without much thought" and "intuitive mostly based on mental model built from previous use". In summary, Designers stated similar microwaves work the same and are therefore very easy to operate, thus "intuitive".

Users also made parallels between intuitive use and prior knowledge. Users stated intuition is influenced by experience and familiarity. In contrast, the opposite held true – that is, an extremely different microwave is unlikely to be intuitive to use. Users also made reference to the buttons and labels. For example, "If the control panel is just like the old mw's control panel, all the buttons are right where she expects them to be and she doesn't have to read anything - not even the labels on the buttons". In summary, Users stated similar microwaves work as expected and result in high levels of successful operation.

4.3 Summary

In summary, there were a total of 134 participants who responded to the survey. Out of 134 participants, 41 (30.6%) were considered Users and 93 (69.4%) were considered Designers. The most common job duty among Designers was HCI. This study contained more participants in the younger age categories, however all age ranges contained participants. Table 19 is a summary of the top 6 attributes from participants' open-ended responses in Table 14. Table 20 is a summary of the top 6 synonymous terms from participants' open-ended responses in Table 15.

Table 19 Top 6 Attributes by percentage of Participants' Open-ended Definitions. (Complete list of attributes are shown in Table 14)

		Group		
#	**Attribute**	User (%)	Designer (%)	Total (%)
1	Easy, Easy to use/understand/learn	58.8%	61.4%	60.7%
2	No instruction/manual needed	47.1%	31.3%	35.9%
3	Reference to buttons, controls, interface, or functions	23.5%	26.5%	25.6%
4	Use was correct, successful, effective, met her goal or did what she wanted	11.8%	21.7%	18.8%
5	Use of past experience/expectations	8.8%	18.1%	15.4%
6	Use was logical or makes sense	23.5%	10.8%	14.5%

Table 20 Top 6 Synonymous Terms by percentage of Participants' Open-ended Responses. (Complete list of attributes are shown in Table 15)

		Group		
#	**Synonymous Term**	Users (%)	Designer (%)	Total (%)
1	Easy to use/understand/figure out	57.6%	63.9%	62.1%
2	Understandable, make sense, logical	42.4%	27.7%	31.9%
3	Simple	9.1%	24.1%	19.8%
4	Instinctual/inherent/innate	18.2%	10.8%	12.9%
5	Natural	21.2%	9.6%	12.9%
6	User friendly	9.1%	13.3%	12.1%

Table 21 presents a summary of the attribute mean values for Users, Designers, and participants as a whole. The mean values of negative questions have been converted to represent positive questions. Further explanations of positive and negative questions are provided in Sections 3.2.3.5 and 4.2.3. See the original tables (Table 16, Table 17, and Table 18) in the Results chapter for more details.

Table 21 Summary of Attributes Mean Values (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). Note: Mean values were converted for negative questions.

Attribute	Users (mean)	Designers (mean)	Total (mean)
Subconscious	3.36	3.84	3.70
Results are effective	4.44	4.59	4.55
Prior Knowledge	3.82	4.10	4.02
Low mental effort	4.53	4.49	4.50
Results are satisfying	3.26	3.45	3.40
Users' physical effort	3.85	3.32	3.47
Time	3.27	3.18	3.21
Cost ($)	4.38	4.06	4.16
Safety	2.59	2.82	2.75
Aesthetics	3.22	3.48	3.40
Level of complexity	4.78	4.67	4.70
Physical size	2.38	2.44	2.42
Mood	3.09	3.26	3.21
Similarity	4.19	4.05	4.09

5 Discussion

5.1 Introduction

The results from Section 4.2 are reviewed and analyzed to answer the research questions and hypotheses. First, demographics are discussed followed by the answering of research question. Next, other attributes are discussed and interesting trends in open-ended responses are examined. Lastly, limitations of the study are presented.

5.2 Demographics

Based on the grouping method, explained in Section 3.2.3.3, there were 41 Users and 93 Designers. It is thought the Designers' group was larger because of the recruitment method and grouping question that distinguished Users from Designers. First, the recruitment method was voluntary, potentially resulting in attracting more participants who are interested in the field of study and had experience in the field. Second, the grouping question contained limitations to accurately separate participants into groups. Despite the limitations of the grouping classifications, participants who had potentially relevant job duties are separated from participants who indicated none of the job duties listed.

Observing Figure 10, distribution of total participants' age ranges in years, and Figure 11, distributions of Users' vs. Designers' age in years, there is a clear right skew, indicating larger numbers of participants in smaller age ranges. Age ranges were more heavily skewed for Users than Designers. This may be due to the jobs of Designers typically requiring more experience or education, resulting in an older age range. However, the recruitment method via social media could have attracted a larger number of younger participants for the Users' group.

Other demographics such as gender, level of education, country of permanent residence, and microwave use followed the author's expectations. Figure 12, distribution of total participants' gender, shows near even frequencies of males and females. This result was desirable because the data included input from both genders. Participants in this study had high levels of education. The highest categories for Users and Designers were *Some College, 4-year College Degree,* and *Masters Degree.* Overall the information collected in this study was from educated individuals. One can infer the results represent a more educated opinion of the term's use and meaning. This factor should be considered if one wishes to generalize the results to others. The majority of the participants were from the United States of America with insignificant numbers from other countries. The results were therefore associated with the views of participants within the United States and cannot speak to the level in agreement of other cultures. Lastly, participants had very frequent use of microwaves; most participants used microwaves daily or weekly. This result showed the use of the microwave scenario throughout the survey was relatable and presumably understandable.

In summary, this study contained more Designers than Users and the grouping of User and Designers contained potential flaws. One could infer the inaccurate group sizes were a result of the recruitment method and the grouping question should be improved by asking participants more direct and precise questions. Participants' gender was represented with about equal frequency and participants generally indicated levels of high education. A majority (90.7%) of participants was from the United States of America suggesting that results are most reflective of opinions within the United States. Frequent microwave use by participants suggests that the use of a microwave in the scenario was acceptable for this survey.

5.3 Research Questions

5.3.1 Question #1

5.3.1.1 From the perspective of statistics

The first research question was: Is there a significant gap between Users' and Designers' definitions of intuitive use? The author's hypothesis was that Users' and Designers' definitions of intuitive use are the same. The results chapter reported a Chi-square test between Users' and Designers' distributions of responses. Table 22 shows a summary of Chi-square values from the Results chapter for the 5 attributes associated with intuitive use in the literature. No P-values were reported less than 0.05, therefore the tests suggest that neither of the groups was significantly different from the other. Interpretations of results are subject to violations of assumptions. The statistical purist would say reporting the p-values on a non-random sample are incorrect. Therefore, the p-values are reported as additional information to help one interpret the results, but should not be taken as fact. Statistical limitations are discussed in section 5.5.3.

Table 22 Summary of Chi-square Test Results for the 5 Attributes Associated with Intuitive Use in the Literature

Attribute	**χ^2 Value**	**P-Value**
Subconscious	4.125	.127
Results are Effective	1.158	.560
Prior Knowledge	4.297	.117
Low Mental Effort	.757	.685
Results are Satisfying	1.358	.507

5.3.1.2 From the perspective of mean values

Observing Table 16, a summary of descriptive statistics about intuitive use attributes, the groups' means were very similar. The largest differences in means were on the attribute *subconscious*; the mean of Users' responses was 3.36 and the mean of Designers' responses was 3.84, a difference of only 0.41. Both groups exhibited a level of agreement between *Neutral* and *Agree.* One can infer that Users' and Designers' definitions of intuitive use are not different. Additionally, both groups had similar mean values for usability versus intuitive use attributes shown in Table 17 and other attributes shown in Table 18. None of the mean values from either group suggest strong disagreement between Users and Designers. One can infer from the results that Users' and Designers' perceptions of intuitive use do not differ from each other when considered as a whole.

5.3.1.3 From the perspective of open-ended responses

Participants' open-ended responses may also give information to answer research question #1. The discussion will consider the top 6 attributes from Table 14 because attributes beyond #6 were each reported by fewer than 10% of total participants. Table 23 is abstracted from Table 14. Users' versus Designers' percentages are classified as similar or different based on a ~10% difference.

Table 23 Users' and Designers' Frequency of Open-ended Response Attributes

#	Open-ended Response Attribute	Users' vs. Designers Percentage
1	Easy, Easy to use/understand/learn	Similar Users = 58.8% Designers = 61.4%
2	No instruction/manual needed	Different Users = 47.1% Designers = 31.3%
3	Reference made to buttons, controls, interface, or functions	Similar Users = 23.5% Designers = 26.6%
4	Use was correct, successful, effective, met her goal or did what she wanted	Different Users = 11.8% Designers = 21.7
5	Use of past experience/expectations	Different Users = 8.8% Designers = 18.1
6	Use was logical or makes sense	Different Users = 23.5% Designers = 10.8%

Easy, Easy to use/understand/learn was mentioned with about equal frequency by Users and Designers, 58.8% and 61.4%, respectively. From that one can infer Users and Designers equally considered this attribute as being a part of the definition of intuitive use. The attribute *Reference made to buttons, controls, interface, or functions* was also mentioned fairly equally between Users and Designers. This attribute relates to attributes discovered in the literature review, specifically, *technical system* and *function* from Table 1. These attributes relate because they both describe intuitive use as involving some system or features of the system they are interacting with. This attribute describes intuitive use as the interaction between an operator and a system. As described in Section 2.2, intuition is not a characteristic of an object, rather the perception between a person and an artifact. Users' and Designers' responses suggest affirming this notion.

The remaining attributes had differences in percentages between Users and Designers. *No instruction/manual needed* differed by 15.8%. Users associated an intuitive use more with not having to read instructions than Designers. From that one can infer Users considered a use intuitive as not requiring reference to instructions, contingent that it makes sense or is logical (attribute #6). Therefore, it is possible Users could identify a use as intuitive when it is not. For example, Users may classify an interface with guidance or on-screen instructions as "intuitive", however the User is not applying prior knowledge, but actually learning new knowledge through guidance or on-screen instructions. The inclusion of these design techniques prevents the User from seeking manuals or reference materials and results in a perceived intuitive use.

Designers' definitions showed more emphasis on goal completion (attribute #4). One can infer Designers' viewed intuitive use as operators perform a given task; if that task is completed and deemed easy then the use is intuitive. Designers' definitions described intuitive use as those that do not require instructions, however as said above, it was less emphasized compared to Users.

Designers' definitions also showed a greater emphasis on past knowledge or expectations (attribute #5). One can infers Designers are more attentive about using operators' past experience and expectations to design systems that are intuitive to use. Users lacked emphasis of past knowledge. One can infer Users were unaware of how past experiences influence the use of new products. The mean values of the attribute *Prior Knowledge* followed this trend; Designers showed a stronger agreement (4.10) than Users (3.82).

Despite the observed nuances between Users' and Designers' percentages, the top 6 attributes were the same for each group. The results suggest there was agreement between Users' and Designers' open-ended definitions.

5.3.1.4 From the perspective of synonymous terms

Participants' open-ended synonymous terms may also give information to answer research question #1. The 6 most frequent terms are considered for Users and Designers. Table 24 shows the top 6 synonymous terms for Users derived from Table 15. Table 25 shows the top 6 synonymous terms for Designers derived from Table 15.

Table 24 Top 6 Synonymous Terms for Users

#	Synonymous Term	User (Count)	User (%)
1	Easy to use/understand/figure out	19	57.6%
2	Understandable, make sense, logical	14	42.4%
5	Natural	7	21.2%
4	Instinctual/inherent/innate	6	18.2%
8	Obvious	4	12.1%
10	Straight forward	4	12.1%

Table 25 Top 6 Synonymous Terms for Designers

#	Synonymous Term	Designer (Count)	Designer (%)
1	Easy to use/understand/figure out	53	63.9%
2	Understandable, make sense, logical	23	27.7%
3	Simple	20	24.1%
6	User friendly	11	13.3%
7	Anticipate outcomes or work as expected	10	12.0%
9	Clear	10	12.0%

Users and Designers most frequently mentioned *Easy to use/understand/figure out* and *Understandable, make sense, logical.* This agreed with the previous findings suggesting that Users' and Designers' definitions are similar. However, the remaining 4 terms are different, indicating nuances in their views. Users' remaining terms appeared to reiterate terms #1 and #2 and did not seem to add additional value. However, Designers' remaining terms appeared to show important nuances. Term #6, *User friendly,* is another common phrase to describe interfaces or products. Further exploration to understand the similarities and differences between intuitive use and user friendly may bring additionally clarity to the language and terms Designers use. Lastly, Designers mentioned term #7, *Anticipate outcomes or work as expected*; this agrees with their open-ended definitions (attribute #4 in Table 23). From this one can infer Designers are more aware of operators' effectiveness - that is achieving goals and outcomes.

5.3.1.5 Summary

The first research question was: is there a significant gap between Users' and Designers' definitions of intuitive use? Based on (1) statistical tests between Users' and Designers' response distributions in Section 5.3.1.1, (2) the mean values of responses in Section 5.3.1.2, (3) comparison between open-ended definition attributes in Section 5.3.1.3, and (4) comparison between open-ended synonymous terms in Section 5.3.1.4 there was no compelling evidence that Users and Designers had a different definition of intuitive use. When Users and Designers were given the opportunity to write open-ended responses, the top 6 attributes that comprised their definitions were the same. However, some differences were found within synonymous terms. Open-ended definitions and synonymous terms revealed points of emphasis for each group. Interesting findings include:

- Most participants described an intuitive use as easy and not requiring instructions or manuals
- Terms synonymous with intuitive use are: easy to use; understandable, makes sense, and logical
- Users and Designers emphasized terms indicative with low mental effort or subconscious thought
- Designers emphasized correct outcomes suggesting their focus on effective interaction

Overall, this is a promising result for researchers and Designers because it affirms their views agree with the views of Users when considered as a whole. A major limitation in this study was the grouping method discussed in Section 5.5.2. Potential recommendations for Designers are discussed in Section 6.2.

5.3.2 Question #2

The second research question was: do Users' and Designers' definitions of intuitive use agree with the literature definition? The author's hypothesis was Users' and Designers' definitions of intuitive use agree with the literature definition. To reject the null hypothesis, there should be strong evidence participants disagree with the statements associated with each term. The criteria used to determine agreement from disagreement are outlined below:

- Agreement: mean values > 3.0
- Disagreement: mean values $\leq$ 3.0

Table 21 from the summary section in the Results chapter can be used to infer the answer to this question. Based on the criteria above, Users and Designers showed agreement with all attributes that comprise the literature definition of intuitive use. The attributes *Results are Effective, Low Mental Effort,* and *Prior Knowledge* displayed stronger levels of agreement (> 4.0). Meanwhile, the attributes *Subconscious* and *Results are Satisfying* showed weaker levels of agreement (between 3.0 - 4.0), but still show agreement based on the criteria above.

5.3.2.1 Results are Effective

Results are Effective had a mean value of 1.56 for Users and 1.41 for Designers. Adjusting to a positive question, one can infer a level of agreement between *Agree* and *Strongly Agree* (4.44 for Users, 4.59 for Designers and 4.55 for participants as a whole). Both groups felt an intuitive use should be effective; therefore, few if any errors are made. Designers showed a stronger level of agreement compared to Users. This follows the same behavior observed in research question #1. In Table 23 Designers mentioned effective goal completion more than Users. In summary, participants had a level of agreement between *Agree* and *Strongly Agree* for the attribute *Results are Effective.* This study provides evidence to accept the attribute *Results are Effective* in the literature definition.

5.3.2.2 Low Mental Effort

Low Mental Effort had a mean value of 1.47 for Users and 1.51 for Designers. Adjusting to a positive question, the author can infer a level of agreement between *Agree* and *Strongly Agree* (4.53 for Users, 4.49 for Designers, and 4.50 for participants as a whole). In summary, participants had a level of agreement between *Agree* and *Strongly Agree.* This study provides evidence to accept the attribute *Low Mental Effort* in the literature definition.

5.3.2.3 Prior Knowledge

Prior knowledge had a mean value of 3.82 for Users, 4.10 for Designers and 4.02 for participants as a whole. Users had a level of agreement between *Neutral* and *Agree*, and Designers had a level of agreement between *Agree* and *Strongly Agree*. The results showed participants as a whole displayed a level of agreement between *Agree* and *Strongly Agree.* From that one can infer participants felt prior knowledge can influence an intuitive use. Designers showed a stronger level of agreement compared to Users. This follows the same behavior observed in research question #1. In Table 23 Designers mentioned use of past experience more than Users. In summary, Users had a level of agreement between *Neutral* and *Agree*, and Designers had a level of agreement between *Agree* and *Strongly Agree*. This study provides evidence to accept the attribute *Prior knowledge* in the literature definition.

5.3.2.4 Subconscious

Subconscious had a mean value of 3.84 for Designers, 3.36 for Users and 3.70 for participants as a whole. Participants had a level of agreement between *Neutral* and *Agree*. However, Users' values are closer to *Neutral* and suggested that the group had mixed feelings about this attribute. Figure 22 shows 63.6% of Users responded either *Agree* (51.5%) or *Strongly Agree* (12.1%), while 30.3% of Users responded either *Disagree* (21.2%) or *Strongly Disagree* (9.1%). Alternatively, Designers showed a slightly different view on this attribute. Figure 22 shows a clear left skew for Designers with equal levels of *Agree* and *Strongly Agree* totaling 67.4%. Designers' levels of *Disagree* and *Strongly Disagree* were also less than Users, 14.4% compared to 30.3%, respectively. Based on the criteria, mean values > 3.0 are considered agreement. However, the distributions in Figure 22 show interesting results.

The Chi-square test result in Table 22 for *Subconscious* was P = .127*,* showing there was not a statistically significant difference between the two distributions. However, this result was a consequence of combining categories (explained in section 5.5.5) to meet assumption #7 (The value of the cell *expecteds* should be 5 or more in at least 80% of the cells) of the Chi-square test. When the categories were not combined, assumption #7 was violated and the P-value from the Chi-square test was .027, suggesting that the distributions were significantly different. The significant P-value from the Chi-square test cannot be used when the assumption is violated, however it does communicate this attribute is borderline. Practically speaking, one can infer Designers had a higher level of agreement with the attribute *Subconscious,* which provides evidence to accept the attribute *Subconscious* in the literature definition. Alternatively, Users showed more uncertainty, which suggests opportunities for future research. In summary, participants had a level of agreement between *Neutral* and *Agree* for the attribute *Subconscious.* This study provides additional information about participants' perceptions of the attribute *Subconscious* in relation to intuitive use. Borderline test results and an unclear User distribution communicate possible opportunities for future research. Based on the criteria this study provides evidence to accept the attribute *Subconscious* in the literature definition. Limitations regarding the interpretation and meaning of the results are discusses in Section 5.5.5. Potential recommendations for Designers are discussed in Section 6.2.

5.3.2.5 Results are Satisfying

Results are Satisfying had a mean value of 3.26 for Users, 3.45 for Designers and 3.40 for participants as a whole. This indicated a level of agreement between *Neutral* and *Agree.* However, this value is closer to *Neutral* and communicated to the author that participants had mixed feelings about their perceptions for this attribute. Figure 30 shows the fairly flat distribution of Users' responses across *Disagree, Neutral,* and *Agree* further confirming this conclusion. The Designers' distribution shows more decisiveness with a greater number of responses for *Agree,* however *Disagree and Neutral* still account for 41.5% of responses. In summary, participants had a level of agreement between *Neutral* and *Agree* for the attribute *Results are Satisfying.* This study provides additional information about participants' perceptions of the attribute *Results are Satisfying* in relation to intuitive use. Mean values close to 3 and unclear distributions suggest possible opportunities for future research. Based on the criteria this study provides evidence to accept the attribute *Subconscious* in the literature definition. Potential recommendations for Designers are discussed in Section 6.2.

5.3.2.6 Open-ended Definitions

In addition to calculating Users' and Designers' Chi-square and mean values, their open-ended definitions are considered as well. The open-ended definition section asked participants to write their definitions of intuitive use. Table 14 shows the most common attributes that comprised Users' and Designers' definitions. The most frequent reported attributes by all participants were: *Easy, Easy to use/understand/learn* (60.7%); *No instruction/manual* (35.9%); *Reference made to buttons, controls, interface, or functions* (25.6%); *Use was correct, successful, effective, met her goal or did what she wanted* (18.8%); and *Use of past experience/expectations* (15.4%). The attributes derived from coding open-ended responses have similar meanings to the attributes found in the literature. Table 26 is a modification of Table 14 and Table 23; it shows the association of open-ended response attributes to the literature definition attributes.

Table 26 Association of Open-ended Response Attributes to Literature Definition Attributes

#	Open-ended Response Attribute	Literature Definition Attribute
1	Easy, Easy to use/understand/learn	Low mental effort
2	No instruction/manual needed	?
3	Reference made to buttons, controls, interface, or functions	Technical system (implied)
4	Use was correct, successful, effective, met her goal or did what she wanted	Results are effective
5	Use of past experience/expectations	Prior Knowledge
6	Use was logical or makes sense	?

Participants' attribute *Easy, Easy to use/understand/learn*, relates to the literature definition *Low mental effort.* Although participants use the word "easy", the one can infers a connection can be made to *Low Mental Effort*. The attribute *No instruction/manual needed* does not specifically relate to any of the literature definition attributes. *Reference made to buttons, controls, interface, or functions* does not have any direct relation to the literature definition attributes, however it does relate to other attributes discovered in the literature review, specifically, *technical system* and *function* from Table 1. This is implied because intuitive use involves a system or features of a system that humans interact with. From this one can infer that this attribute describes intuitive use as the interaction between an operator and a system. As described in Section 2.2, intuition is not a characteristic of an object, rather the relation between a person and an artifact. The attribute *Use was correct, successful, effective, met her goal or did what she wanted* relates to *Results are effective* because the attribute describes a use that is effective (correct) and does not contain errors. The attribute *Use of past experience/expectations* relates to *Prior Knowledge* because both represent knowledge from the past. Lastly, *Use was logical or makes sense* does not specifically relate to any of the literature definition attributes. While the open-ended responses do not provide indisputable evidence, it does show support for agreement with select attributes of intuitive use presented in the literature.

5.3.2.7 Comparison with Literature Results

The following is a comparison between this survey and a similar survey from the literature. In 2006, Mohs conducted a survey with 22 naïve participants to derive an initial definition of intuitive use. More details are available in Section 2.9 (Mohs et al., 2006). Table 27 shows the comparison between Mohs' survey results and this study's results. The statements from Mohs' survey were related to attributes from the literature definition by Hurtienne (2011). The last column indicates the status between the two studies' results. Agreement means the results are in agreement and disagreement mean the results disagree with one another. "N/A" is written where attributes from the literature definition column did not have associated statements in Mohs' survey.

Table 27 Comparison with Mohs' Survey Results

Literature Definition Attribute	Mohs' Survey Statement	Status
Results are Effective	Operation that is based on intuitiveness is still efficient (still supports a fast and error-free task fulfillment) even when I already know the system.	Agreement
Low Mental Effort	N/A	N/A
Prior Knowledge	Intuitiveness is the use of previous experiences in a new context.	Agreement
Results are Satisfying	N/A	N/A
Subconscious	Intuitive means to recognize something without conscious thinking.	Agreement

Table 27 shows agreement between the attributes *Results are Effective*, *Prior Knowledge* and *Subconscious* for this study and the results from Mohs' survey. A comparison cannot be made between the attributes *Low Mental Effort* and *Results are Satisfying* because they were not present in Mohs' survey. Mohs survey reported a value of 1.3 (the equivalent of between *Agree* and *Strongly Agree*) for the associated attribute *Results are Effective,* 1.0 (the equivalent of *Agree*) for the associated attribute *Prior Knowledge,* and .9 (the equivalent of between *Neutral* and *Agree*) for the associated attribute *Subconscious.*

For this study the attribute *Results are Effective* also had a mean value between *Agree* and *Strongly Agree,* showing consistent results between the two studies. For the attribute *Prior Knowledge* Users had a mean value between *Neutral* and *Agree*, these values were slightly less than Mohs results, but still considered within the same range. Designers had a mean value between *Agree* and *Strongly Agree*, these values were slightly more than Mohs' results, but still considered within the same range. For this study the attribute *Subconscious* also had a mean value between *Neutral* and *Agree,* showing agreement between the two studies. Both studies provided compelling evidence to include the attributes *Results are Effective*, *Prior Knowledge* and *Subconscious* in the literature definition.

5.3.2.8 Summary

In summary, participants' levels of agreement toward the attributes *Results are Effective, Low Mental Effort,* and *Prior Knowledge* were between *Agree* and *Strongly Agree.* Additionally, participants' open-ended definitions reinforced these attributes. Participants' levels of agreement toward the attributes *Subconscious* and *Results are Satisfying* were between *Neutral* and *Agree.* Additionally, both attributes were not clearly present in participants' open-ended responses. The author recommends investigating the attributes *Subconscious* and *Results are Satisfying* further. Similarly, the attribute *Subconscious* was the lowest scoring in Mohs' survey. Limitations regarding the interpretation and meaning of the results are discusses in Section 5.5.5. Future work for Researchers are discussed in Section 6.3. Potential recommendations for Designers are discussed in Section 6.2. Overall, participants did not exhibit any signs of strong disagreement and results were consistent with previous survey results. This confirms the author's hypothesis. There was no evidence showing Users and Designers disagree with the attributes for intuitive use presented in the literature.

5.3.3 Question #3

The third research question was: can Users and Designers distinguish the attributes separating intuitive use from usability? The author's hypothesis was that Users' and Designers' can distinguish attributes separating intuitive use from usability. High values corresponded to attributes not necessary for an intuitive use; therefore participants were distinguishing between intuitive use and usability. Low values corresponded to attributes that were influential for intuitive use; therefore participants could not distinguish between intuitive use and usability. To reject the null hypothesis, there should be strong evidence participants cannot discriminate between the distinguishing attributes. The criteria used to determine if participants can distinguish the difference are outlined below:

- Participants can distinguish usability from intuitive use: mean values > 3.0
- Participants cannot distinguish usability from intuitive use: mean values ≤ 3.0

Table 28 shows a summary of Chi-square test results for the 3 attributes distinguishing usability and intuitive use. No P-values were reported less than 0.05, therefore the tests suggest that none of the groups were significantly different from the other. Statistical limitations are discussed in section 5.5.3.

Table 28 Summary of Chi-square Test Results for the 3 Attributes Distinguishing Usability and Intuitive Use

Attribute	χ^2 Value	P-Value
Users' Physical Effort	4.539	.103
Time	.227	.893
Cost ($)	1.524	.467

5.3.3.1 Users' Physical Effort

The first attribute distinguishing intuitive use from usability is *Users' Physical Effort.* Figure 31 shows a box plot of Users' and Designers' responses. Users distinguished *Users' Physical Effort* more than designers, 3.85 versus 3.32, respectively. Participants as a whole had a mean value of 3.47. This indicated a level of agreement between *Neutral* and *Agree* for both groups. Interestingly, Users showed a higher level of agreement compared to Designers, meaning Users were able to make the distinction claimed in the literature better than Designers. Despite the differences in mean values the Chi-square test showed the distributions between Users and Designers are not significantly different. It was not clear if the Users understood the true reason why the attribute *Users' Physical Effort* distinguishes intuitive use from Usability, as explained in Section 2.5. However, one can infer Users associated physical effort less with intuitive use than Designers. Based on the criteria, this study provides evidence that a use can be intuitive regardless of users' physical effort. One can infer participants were able to distinguish usability from intuitive use based on this attribute.

5.3.3.2 Time

The second attribute distinguishing intuitive use from usability is *Time.* Table 21 reports a mean value of 3.27 for Users, 3.18 for Designers, and 3.21 for participants as a whole. This indicated a level of agreement between *Neutral* and *Agree.* Figure 34 shows Users and Designers had similar views of this attribute, also reiterated by a P-value of .893. Users' and Designers' distributions showed nearly even frequencies between *Agree* and *Disagree,* with agree scoring a few percentage points higher resulting in a mean above 3.0. One can infer those who agreed with the statement thought of intuitive use as perhaps cognitive effort, which is independent of time. Those who disagreed with the statement perhaps thought an intuitive use is quick or fast and therefore time is important. It was not surprising that participants associated time with intuitive use because the attribute appears in the literature by several authors (Blackler et al., 2003b; Britton et al., 2013; Buetow & Mintoft, 2011; Bullinger et al., 2002; Dane & Pratt, 2007; Hadar & Leron, 2008; Hodgkinson et al., 2009; Hurtienne, 2011; Ilie, Turel, & Witman, 2013; Kahneman, 2002; Khalid, 2006; Raskin, 1994; Stanovich & West, 2000; Sundar et al., 2014; Swaak & de Jong, 1996). The literature states intuitive use is associated with S1 processing (Dane & Pratt, 2007; Kahneman, 2002), which is fast, quick and automatic. However, as Hurtienne (2011) points out, *time* has an equal likelihood to enhance, decrease, or not effect intuitive use. It is possible to contrive a design that allows operators' mental states to remain subconscious, however the length of time to complete the task is time consuming and inefficient. Although an intuitive use is often quick, *time* is not mandatory for an intuitive use. This is an important distinction Designs must make.

Participants did not show strong levels of agreement and observation of the distribution indicated participants had near even frequencies of *Agree* and *Disagree.* An unclear distribution indicates opportunities for future research on this attribute. However, based on the criteria, this study provides evidence that a use can be intuitive regardless of time. Potential recommendations for Designers are discussed in Section 6.2.

5.3.3.3 Cost ($)

The third attribute distinguishing intuitive use from usability is *Cost ($).*Table 21 reports a mean value of 4.38 for Users, 4.06 for Designers, and 4.16 for participants as a whole. This indicated a level of agreement between *Agree* and *Strongly Agree.* Observation of Figure 36 show Users and Designers had similar views of this attribute, also reiterated by a P-value of .467. Distributions were left skewed indicating participants agreed *Cost ($)* did not influence intuitive use. Participants showed strong levels of agreement, indicating they could distinguish the attribute *Cost ($)* better than Designers*.* Based on the criteria, this study provides compelling evidence that a use can be intuitive regardless of cost. One can infer participants can distinguish usability from intuitive use based on this attribute. Potential recommendations for Designers are discussed in Section 6.2.

5.3.3.4 Summary

The third research question was: can Users and Designers distinguish the attributes separating intuitive use from usability? Based on the criteria outlined in section 5.3.3, Users' and Designers' mean values indicate they do not associate the attributes *Users' Physical Effort, Time,* and *Cost ($)* with intuitive use. From that one can infer participants can distinguish between usability and intuitive use. However, as stated above, the distribution for *time* indicated a near even frequency between *Agree* and *Disagree.* Interesting findings include:

- Participants appeared to be divided on the attribute *time,* additional education is needed so that Designers understand how time relates to usability and intuitive use.
- Participants felt strongly that *Cost ($)* is not associated with intuitive use

Overall, participants did not exhibit any signs of strong disagreement. This suggests that the author's hypothesis was correct. There was no evidence showing Users and Designers associated the distinguishing attributes with intuitive use.

5.4 Other Attributes

Table 29 shows a summary of Chi-square test results for other attributes. No P-values were reported less than 0.05, therefore the tests suggest that none of the groups were significantly different from the other. Statistical limitations are discussed in section 5.5.3. The criteria used to determine if participants think attributes affect intuitive use are outlined below:

- The attribute affects intuitive use: mean values > 3.0
- The attribute does not affects intuitive use: mean values ≤ 3.0

Table 29 Summary of Chi-square Test Results for Other Attributes

Attribute	χ^2 Value	P-Value
Safety	1.443	.486
Aesthetics	1.943	.379
Level of Complexity	1.202	.548
Physical Size	.841	.657
Mood	.241	.886
Similarity	.1732	.421

5.4.1 Safety

Participants did not feel *Safety* strongly affects intuitive use. Mean value were 2.59 for Users, 2.82 for Designers and 2.75 for participants as a whole. Figure 37 clearly shows a distribution representing disagreement for Users and a slightly more balanced distribution for Designers. From that one can infer *Safety* is not an attribute that affects one's perception of intuitive use. Users felt stronger about this statement; only 18.8% indicated *Agree* and 3.1% indicated *Strongly Agree.* When considering intuitive use, Designers appear to be more concerned with the impacts of safety. Safety is an attribute that responsible Designers must hold paramount, and it appears it influenced their perceptions of intuitive use. The few participants who did strongly agree with the attribute *Safety* said unsafe products are harder to operate and result in more time spent learning. One can infer participants were relating the impacts of safety rather than the concept of safety itself. The implications of safety are captured by other attributes such as *Results are Effective* and *Prior Knowledge.* Based on the criteria one can infer participants do not perceive the attribute *Safety* to affect intuitive use.

5.4.2 Aesthetics

Users' mean values for the attribute *Aesthetics* were 3.22 for Users, 3.48 for Designers and 3.40 for participants as a whole. This indicated a level of agreement between *Neutral* and *Agree.* However, this value is closer to *Neutral* and communicated to the author that participants had mixed feelings about their perceptions for this attribute. Figure 40 shows the Users' distribution contains more variations than the Designers, which contains a clearer left skew. The Designers who strongly agreed with the attribute *Aesthetics* said aesthetics relate to population stereotypes and industry standards for color and icon design. Users who strongly agreed said aesthetics shapes the way we interact with machines and visual design can reduce the need for instructions. It appears aesthetics impact the intuitive use of operators in different way and for different reasons. Additionally, some participants' comments on aesthetics were not truly about aesthetics at all. Based on the criteria one can infer participants perceive the attribute *Aesthetics* to affect intuitive use.

5.4.3 Level of Complexity

Participants felt *Level of Complexity* strongly affects intuitive use. Mean values were 4.78 for Users, 4.67 for Designers and 4.70 for participants as a whole. Figure 42 clearly shows strong levels of agreement for Users and Designers. Results from the open-ended response section explain why participants felt so strongly about this attribute. Some Designers felt that "as level of complexity goes up, intuitiveness does down". Complexity leads to the need for instructions and thus not an intuitive use. Other Designers felt that processes can be complex yet intuitive to use. This is because some functions used within a complex system can be intuitive to use while others are not. Additionally, some systems are actually very complex, but operators do not perceive them as so. Stating level of complexity affects intuitive use is not incorrect, but rather is incomplete. The results from Mohs' (2006) survey shows complex systems become easier to use with increased intuitiveness. Furthermore, Hurtienne (2011) describes intuitive use as "the extent to" indicating there are some features that may be used intuitively while others are not. Additionally, Britton (2013) agrees that intuitive use can apply to the interface's key functions. Based on the literature and Designers' open-ended responses it can be concluded that intuitive use is possible within complex systems, and key features can be used intuitively. An important addition to this concept identified by Designers responses was operator perception. A system could indeed be very complex mechanically or electronically, however the visibility of that complexity to the operator could influence the operator's perception of intuitive use.

Users make the same parallel between complexity and intuitive use, stating "The more complex, the less intuitive". For the same reasons described above, this is not a complete view of the relationship between *Level of Complexity* and intuitive use. Some Users said that if the level of complexity is within the operator's current knowledge base then it can be intuitive to use. The author can infer *Level of Complexity* is relative to each operator because it is based on the operator's knowledge. Similar connections in the literature are made between matching the user interface with their mental model (Loeffler et al., 2013), the automation of processes due to frequent encoding and retrieval (Hurtienne & Blessing, 2007), and skill-based performance (Rasmussen, 1986). In summary, based on the criteria above one can infer participants perceive the attribute *Level of Complexity* to affect intuitive use. Furthermore, *Level of Complexity* for an intuitive use varies based on the operator's prior knowledge.

5.4.4 Physical Size

Participants felt *Physical Size* does not affect intuitive use. Mean values were 2.38 for Users, 2.44 for Designers and 2.42 for participants as a whole. Figure 44 shows a right skew of both distributions. From that one can infer participants tend to disagree with this attribute affecting intuitive use. The open-ended responses for the 3 participants who answered the question *Strongly Agree* did not provide responses relevant to the topic. Based on the criteria above one can infer participants do not perceive the attribute *Physical Size* to affect intuitive use.

5.4.5 Mood

Participants tended toward *Neutral* for the attribute *Mood* affecting intuitive use. Mean values were 3.09 for Users, 3.26 for Designers and 3.21 for participants as a whole. The author can infer participants tended to be indifferent about this attribute affecting intuitive use. The open-ended response section yields an interesting finding. Participants stated operator's mood could affect their perception. This suggests perceived intuitive use could change based on mood regardless of the system or interface. However, agreement was not strong and indicates opportunities for future work. Based on the criteria above one can infer participants perceive the attribute *Mood* to affect intuitive use.

5.4.6 Similarity

Participants' responses were between *Agree* and *Strongly Agree* for the attribute *Similarity* affecting intuitive use. Mean values were 4.19 for Users, 4.05 for Designers and 4.09 for participants as a whole. The author can infer participants tended to agree with this attribute affecting intuitive use. Additionally, Figure 48 shows distributions were heavily left skewed. Open-ended responses for participants who indicated *Strongly Agree* revealed similarity is associated with prior knowledge. Participants said a microwave similar to Sarah's previous microwave meant she could use skills and prior knowledge she developed and did not have to learn new skills; this behavior in indicative of an intuitive use. Participants' responses agree with the literature. Raskin (1994) states, "intuitive equals familiar". From this one can infer prior knowledge is associated with similarity or familiarity. Based on the criteria above one can infer participants perceive the attribute *Similarity* to affect intuitive use.

5.4.7 Summary

The section exploring other attributes revealed fruitful findings. The attributes *Safety, Mood, and Physical Size* do not appear to affect participants' perceptions of intuitive use. Meanwhile, the results from attributes *Aesthetics, Level of Complexity,* and *Similarity* suggest they affect participants' perceptions of intuitive use. Interesting findings include:

- Perceived *Safety, Physical Size,* and *Mood* do not appear to affect participants' perception of intuitive use.
- Perceived *Aesthetics, Level of Complexity,* and *Similarity* appear to affect participants' perception of intuitive use.
- Low levels of perceived complexity are associated with intuitive use.
- For complex systems, Designers should focus on making key features and functions intuitive to use.
- Future research to investigate the affects of mood on intuitive use is recommended.

Overall, this section provides information about other attributes Designers often consider in the design process. The results provide guidance to Designers about attributes that should (and should not) be considered when designing for intuitive use. The results represent perceived intuitive use and should not be interpreted as factors that caused quantitative differences in intuitive use.

5.5 Limitations

5.5.1 General

Claims made in regard to each research question cannot be generalized to the larger population of Users and Designers for two main reasons: The sample size was not sufficient and the sample was not randomly collected. According to Survey Monkey ("Sample Size for Survey," n.d.) populations over one million require at least 97 participants at a 10% margin of error. The sample sizes for Users and Designers were each less than 97. Additionally, the sample was not collected randomly, as described in Section 3.4. This also implies statistical limitations discussed in Section 5.5.3.

Within the Qualtrics web survey participants could navigate forward and backward between blocks. This made it possible for participants to go back to a previous block and change their responses. Although the open-ended response section was presented first, there is no way to verify that answers were not changed after viewing the latter parts of the survey.

The results of this study did not consider the effects of age, gender, job duties, or education of participants. Gudur and Blackler (2013; 2009) showed that age affects some attributes relating to intuitive use. Whether participants' perceptions are impacted is unknown. Any differences in perceptions based on these factors could be confounding factors to this study. These factors were not explored in this study however, further analysis or follow on studies are recommended.

5.5.2 Designer and User Grouping

One of, the largest limitations of this study was the method for grouping participants. Participants were distinguished as Users or Designers based on the job duties they indicated, as explained in Section 3.2.3.3. The intent of this question was to separate participants whose primary job duty was to design products and interfaces from those who did not. Therefore, the Designer group should have only included those who have designed interfaces and products for others. In retrospect, this question may have been too ambiguous to classify participants as Designers for the purposes of this study. Observing Figure 9, the sum of job duties for Designers, there were many Designers who indicated experience with several job duties. However, a participant who indicated a job duty was, for example, Ergonomics, does not mean they were responsible for or had experience with the design of interfaces. "Designers" then is being used more generally to include Designers of all sorts. Therefore, one must consider the potential for inaccurate discrimination between Users and Designers for the presented results and conclusions drawn from the study.

5.5.3 Statistical

The Chi-square test results are subject to all assumptions being met. This study violated assumption #1: data were not obtained through random selection. The statistical purist would say reporting p-values for a non-random sample is incorrect. Therefore, the p-values are reported as additional information to help one interpret the results, but should not be taken as valid for the larger population.

5.5.4 Research Question 1

The open-ended results derived in Section 5.3.1 contain limitations. When considering the percentages of attributes in open-ended definitions as a whole they were relatively weak. The top attribute, *Easy, Easy to use/understand/learn,* was only mentioned by about 60% of participants. This means 40% of participants held another attribute as important for intuitive use or additional attributes are needed beyond *Easy* to represent their complete definition. The low percentages showed the breadth of participants' responses.

5.5.5 Research Question 2

Chi-square results showed conflicting evidence depending on the violation of assumption #7 (the value of the cell *expecteds* should be 5 or more, listed in Section 3.5.3). When the assumption was violated the test yielded a P-value less than 0.05, however when categories were combined (*Strongly Disagree with Disagree* and *Agree with Strongly Agree*) the P-value was greater than 0.05. Additional statistical methods could be used; however they were not pursued in this study.

The results and conclusions are subject to accurate associations between Mohs' survey questions and the attributes. The methodology and survey design were different in both studies and it is not guaranteed that results can be accurately compared. Furthermore, numbers of participants were drastically different (22 participants in Mohs' study versus 134 participants in this study) and the studies were conducted in different countries. Finally, the original language for Mohs' survey was in German and was translated into English to be compared with this study's result. Additional uncertainty is added by potential errors in translation or cultural differences of definitions.

5.5.6 Open-Ended Attributes

5.5.6.1 Level of Complexity

Some participants' referred to complexity objectively, relating complexity to the device itself. Others referred to complexity as it is perceived by the operator. Participants who saw complexity objectively stated the device itself, either electronically or mechanically, may be complex, but the operation is intuitive. Participants who saw complexity as perceived complexity disagreed. For example, "The perceived level of complexity will affect the judgment of intuitiveness " and "Perceived level of complexity. Could be complex in the sense of involving multiple steps, but the steps would have to be easy to figure out." This relates to the step-by-step computer wizard example in Section 2.5 of the literature review. A complex process could be intuitive to use with the use of a step-by-step wizard. In this situation, more physical effort and time is being exchanged for an intuitive use.

5.6 Implications

The results from research question #1 suggest that there was not a significant gap between Users' and Designers' definitions of intuitive use. Similar views among groups facilitate collaboration and advancement in intuitive use of interfaces and systems. From that, one can infer the design methodologies and tools presented in the literature can be applied by Designers and will be well received and understood by Users when considered as a whole. Practically speaking, if a Designer is approached by a User and asked for an "intuitive interface", the Designer can more accurately imagine what the User means. However, this does not imply Designers should not seek additional information or attempt to clarify the User's request, for not all Users' definitions of an "intuitive interface" agree with those of all Designers. As seen in many of the distributions, for example Figure 22, most Users agreed with the attribute *subconscious*, however there were individuals who indicated *Disagree* or even *Strongly Disagree* with this attribute. Therefore, it is important to consider individual differences.

The results from research question #2 suggest that participants agreed with the attributes defining intuitive use in the literature. This result is helpful for researchers because it confirms the literature definition is consistent with participants' views and supports it as a working definition. The definition of intuitive use is the foundation of this field of study. One can infer agreement with the definition transfers to agreement with the frameworks and design methodologies. Verifying that participants' perceptions of intuitive use match the literature definition is an important step for future research and adoption of intuitive use in interface design.

The results from research question #3 suggest that participants can distinguish usability from intuitive use. Although intuitive use is a sub-concept of usability (Hurtienne, 2011), the distinction between the two are important. The focus of intuitive use is reducing mental effort, whereas usability is a property of an overall system (quality of use in a context) (Bevan & Macleod, 1994). Participants' response distributions suggest that they are uncertain about the attribute *time*, despite meeting the criteria for agreement in this study. *Time* is perhaps the most important attribute distinguishing the two.

Imagine designing an automatic ticket machine at a theme park where visitors can purchase admittance tickets. A machine emphasizing usability, and therefore the attribute *time* would be concerned with how quickly a visitor could purchase a ticket with practice. Therefore, after possibly training and receiving practice the visitor could purchase a ticket very quickly. Alternatively, a machine emphasizing intuitive use does not require the purchase of tickets to occur quickly. Instead, the machine would use visitors' prior knowledge (perhaps from an ATM machine) and focus on reducing mental workload. Therefore, theme park workers are not needed to provide instruction. In this situation, designing for intuitive use is desirable because visitors most likely visit infrequently and the speed advantage offered by a usable system would not be realized.

The example above demonstrates the importance for Designers to be able to distinguish usability from intuitive use. The results from this study are important because they reveal Designers may be unaware how the attribute *time* can distinguish usability from intuitive use. Recommendations for designers are presented in Section 6.2.

Section 5.4 discussed other attributes and their potential affects on perceived intuitive use. These results are important for researchers and Designers because they identify additional factors to consider when designing for intuitive use. For researchers it identifies attributes to consider for future experiments. For Designers it helps guide difficult design decision where requirements come in conflict. For example, imagine a Designer has to make a trade-off between the type of material to use and the associated cost; higher quality materials would increase cost. If the User's primary requirement was intuitive use, the results from this study can guide the Designers decision. It was shown aesthetics affect participants' perception of intuitive use while cost does not. Therefore, if intuitive use is the chief requirement and perceived intuitive use is important then that Designer should choose aesthetics even if it will increase the cost. Of course additional considerations must be taken into account with regard to cost, however this example demonstrates how the results from this study can help inform Designers' decision-making processes.

In summary, this research suggests there is not a significant gap between Users' and Designers' definitions of intuitive use. Nevertheless, there will certainly be differences, and discussing its meaning with Users is recommended to account for individual differences. This research also provides compelling evidence that the literature definition of intuitive use is acceptable and can be affirmed as a working definition. Next, distinguishing between usability and intuitive use on the attribute *time* is questionable. Designers should be careful when using these terms and clarify with Users. Finally, exploration of other attributes informs Designers when making design decisions. Recommendations for researchers and Designers are presented in the Conclusions chapter.

6 Conclusions

The primary purpose of this research was to verify Users' and Designers' definitions of intuitive use with each other and with the literature. Also, the research was intended to assess Users' and Designers' abilities to distinguish usability from intuitive use. Lastly, the research sought to identify guidelines and recommendations for researchers and Designers. A through review of the intuitive use literature revealed attributes, definitions, frameworks, and design methodologies. Additionally, areas of disagreement and uncertainty were uncovered. A survey was developed in Qualtrics to collect the views of Users and Designers. The attributes from the literature review were instrumental in the design and development of the survey. The goal of this thesis was to answer the following research questions:

1. Is there a significant gap between Users' and Designers' definitions of intuitive use?
2. Do Users' and Designers' definitions of intuitive use agree with the literature definition?
3. Can Users and Designers distinguish the attributes separating intuitive use from usability?

6.1 Summary

The results suggested that Users and Designers do not have a significant gap in their definitions of intuitive use. However, the grouping methodology had limitations, as discussed in Section 5.5.2. Additionally, Users and Designers agreed with the definition presented in the literature and the results were consistent with a previous study conducted by Mohs (2006). The attributes *Subconscious* and *Results are Satisfying* showed the most uncertainty and are recommended for future work (Section 6.3). Next, the results suggested that Users and Designers could distinguish the attributes that are not associated with intuitive use. The attribute *Time* showed the most uncertainty and is recommended for future work (Section 6.3). Lastly, the 3D Guidelines for Intuitive Use were developed to assist designers and future work is recommended for researchers.

6.2 Recommendations for Designers

6.2.1 Cautions

From research question #1 it appears Users and Designers do not have differing views on the attributes discussed in the study. This is encouraging information for Designers, suggesting both groups have the same meaning about the terms intuitive use when considered as a whole. However, the Results and Discussion chapters give the following cautions for Designers:

- Designers should be cautious when discussing the attribute *Subconscious*; the word subconscious should be clearly defined with Users and its implications discussed.
- Designers should be cautious when discussing the attribute *Results are Satisfying* with Users. Satisfying results should be clarified; discuss the Users' desires for satisfaction, how it will be measured and how it relates to intuitive use.
- Designers should be cautious when discussing usability and intuitive use. Designers should explain the attributes that distinguish the two; special attention should be spent on the attribute *Time.*

6.2.2 Guidelines

From the Results and Discussion chapters the author has derived guidelines to help Designers properly incorporate intuitive use into their design. The process is called the 3D Guidelines for Intuitive Use. The process comprises the following three stages:

- Stage 1: Distinguish – Designers should understand and communicate the distinction between usability and intuitive use to Users.
- Stage 2: Decide – Designers should decide which is important, design for usability, design for intuitive use, or perhaps a subset of intuitive use or usability.
- Stage 3: Design – If intuitive use is selected, this stage provides guidance for designing for intuitive use

The following elaborates on each stage of the 3D Guidelines for Intuitive Use.

6.2.2.1 Distinguish

The focus of intuitive use is reducing mental effort, whereas usability is a property of an overall system (quality of use in a context) (Bevan & Macleod, 1994). The ISO definition of usability contains three criteria (1) effectiveness, (2) efficiency, and (3) satisfaction (ISO, 1998). Designers should refer to Table 3 to see the relevance of usability criteria with design for intuitive use. Part of the usability criterion agrees with intuitive use, therefore intuitive use is a sub-concept of usability. The attributes that are NOT correlated with intuitive use are *Users' Physical Effort, Time* and *Cost ($)* (Hurtienne, 2011).

Based on the attributes not correlated with intuitive use, the following can help Designers distinguish usability from intuitive use:

- Intuitive use is possible even when the operator exerts a sizable amount of **physical effort**. For example, operating an effortful valve or scanning a large interface to view a parameter. As long as mental effort remains subconscious, intuitive use is possible.
- Intuitive use is possible even when the **time** to complete the task is quite long, For example, imagine clicking through a long step-by-step menu; time is passing, but the simple steps allow the interface to be used subconsciously. In this situation, more physical effort (more clicking) and time is being exchanged for intuitive use.
- Intuitive use is possible even when the **cost ($)** of resources is substantial. Consider the examples presented in the two previous bullet points. The effects could result in higher financial costs due to inefficiency. However, in most cases, systems that are intuitive to use should lead to reduced costs because of reducing training and hopefully, increasing productivity Additionally, results suggest that participants' perceptions of intuitive use are not affected by cost.

Designers should see Section 5.6 for more examples describing usability versus intuitive use.

6.2.2.2 Decide

In this stage Designers should decide what is important for the given design scenario, intuitive use or usability. Perhaps both are desired within a larger system, in which case Designers should determine which features and functions are candidates for each design approach. In the context of a complex system, designers should focus on making select functions of the system or interface intuitive to use. Candidate functions for intuitive use can be identified by:

- The function's frequency of use
- The function's time sensitivity given an operator's level of training
- Whether or not the function requires greater working memory
- Whether or not the function is used under high levels of stress

Stage one can inform decisions in stage two. Hence, knowing the differences in the design approaches can lead to choosing the proper approach. Intuitive use is a promising approach for the following situations (Loeffler et al., 2013, p. 1):

- Beginner Users
- Infrequent Users
- Diverse User groups needing to work with the same system
- Users unwilling to learn how to operate a product

- Systems being used under stressful conditions

The following attributes **do not** appear to affect the perception of intuitive use:

- Safety
- Physical size

The following attributes appear to affect the perception of intuitive use:

- Aesthetics
- Perceived level of complexity
- Mood
- Similarity

The Designer should (1) consider candidate functions for intuitive use using the criteria given as a guide, (2) consider the type of users and potential environmental conditions, and (3) consider the attributes that affect Users perception of intuitive use to reach a well-reasoned decision.

6.2.2.3 Design

The purpose of the design step is to truly design the particular interface, system, function, etc. for intuitive use. The most important task a Designer can perform to promote intuitive use is seeking Users' prior knowledge. Ask Users what software they have experience with, where they grew up to solicit population stereotypes, what training Users of the system already have, or what extra curricular activities are common among operators of the system. One could say the Designer should seek perfect positive transfer of training between the Users' prior knowledge and the function of the system.

The literature review presents several resources to guide Users in designing for intuitive use. Resources include:

- Design frameworks listed in Section 2.6, especially Wensveen's (2004) design framework for coupling action and function
- Blackler's (2006) three design principles (Section 2.8)
- Blackler's and Hurtienne (2007) checklist of principles for intuitive interaction (Section 2.8)
- Loeffler's (2013) IBIS design method (Section 2.8)
- Hurtienne's (2011) image schemata design method

- Blackler's (2010) technology familiarity questionnaire

The resources provide techniques and methods to begin designing for intuitive use.

6.3 Future Work

The results provide compelling evidence to affirm the literature definition of intuitive use given the limitations, as discussed in 5.5. Several attributes, including *Results are Effective, Low Mental Effort,* and *Prior Knowledge* showed strong levels of agreement and were consistent with previous work (Mohs, Hurtienne, Scholz, et al., 2006). Therefore, future research is not needed for these attributes because they appear to be validated. Alternatively, future work is recommended for the attributes:

- *Subconscious*
- *Results are Satisfying*

These attributes saw lower levels of agreement among participants, between *Neutral* and *Agree.* While participants did not disagree with these attributes, the data appeared to show mixed opinions. To be clear, the author is not claiming whether or not attributes are truly telling of intuitive use, but rather reporting the perceptions of Users and Designers. That being said, further research is needed to better understand participants' perceptions of these attributes.

This study also tested participants' views of other attributes. Participants indicated the following attributes affect intuitive use:

- *Aesthetics*
- *Level of complexity*
- *Mood*
- *Similarity*

Future work is recommended to better understand how these attributes affect participants' perceptions of intuitive use. Designers' synonymous terms also revealed future work to understand the relationship between user friendly and intuitive use (Section 5.3.1.4).

Finally, future work is recommended for research questions #1: Is there a significant gap between Users' and Designers' definitions of intuitive use? This study contained limitations (Section 5.5.2) in the grouping method of participants. A follow-up study using interviews is recommended so that the research can better distinguish the participant's past experience and properly classify them as a User or a Designer. Understanding how Designers and Users differ will lead to improved communication between groups.

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Appendix A - Attributes Matrix

Source	**Technical System**	**Knowledge through prior experience**	**Transferring knowledge of features**	**Rule-based (SRK) - Skill Based**	**Location**	**Appearance**	**Function**	**Subconscious Process**	**Fast/rapid/quick/immediate**	**Effortless**	**Automatic/natural**	**Familiar**	**Non-verbalizable**	**Effective interaction (correctness)**	**Cognitive Process**	**Dual Process Theory - S1**	**Easy-to-use**
Bodi & kaulich (Bödi & Kaulich, 1992)					x				x								
(Raskin, 1994)		x	x						x			x					
(Swaak & de Jong, 1996)		x		x				x	x				x		x		
(Bullinger et al., 2002)		x									x	x					
(Kahneman, 2002)									x	x	x			x	x	x	
(Blackler et al., 2003a)		x	x	x	x	x	x	x	x						x		x
(Wensveen et al., 2004)					x	x	x				x						
(Khalid, 2006)								x	x		x				x	x	
(Mohs, Hurtienne, Israel, et al., 2006)	x	x						x			x			x	x		

Source	Technical System	Knowledge through prior experience	Transferring knowledge of features	Rule-based (SRK) - Skill Based	Location	Appearance	Function	Subconscious Process	Fast/rapid/quick/immediate	Effortless	Automatic/natural	Familiar	Non-verbalizable	Effective interaction (correctness)	Cognitive Process	Dual Process Theory - S1	Easy-to-use
(Blackler et al., 2007)		x	x		x	x	x	x	x			x	x		x		
(Dane & Pratt, 2007)		x						x	x	x	x			x	x	x	
(Hurtienne & Blessing, 2007)	x	x						x						x			
(A. Naumann et al., 2007)	x	x		x		x		x						x	x		
(Hadar & Leron, 2008)								x	x	x	x				x	x	
(Turner, 2008)		x						x			x	x			x		x
(Hodgkinson et al., 2009)		x						x	x						x	x	
(Israel et al., 2009)	x	x	x		x	x	x	x				x		x	x		x
(Blackler et al., 2010)		x	x	x				x	x		x	x	x	x	x		
(Yoon & Manurung, 2010)									x		x			x			
(Buetow & Mintoft, 2011)								x	x		x		x		x		
(Hurtienne, 2011)		x	x	x				x	x		x	x	x	x	x		x

Source	Technical System	Knowledge through prior experience	Transferring knowledge of features	Rule-based (SRK) - Skill Based	Location	Appearance	Function	Subconscious Process	Fast/rapid/quick/immediate	Effortless	Automatic/natural	Familiar	Non-verbalizable	Effective interaction (correctness)	Cognitive Process	Dual Process Theory - S1	Easy-to-use
(Britton et al., 2013)		x	x		x			x	x				x	x	x		
(Ilie et al., 2013)		x		x				x	x	x	x	x			x	x	
Percentage (%) of Papers	17.4 %	69.6 %	30.4 %	26.1 %	26.1 %	21.7 %	17.4 %	73.9 %	69.6 %	17.4 %	56.5 %	34.8 %	26.1 %	43.5 %	73.9 %	26.1 %	17.4 %

Appendix B - Full Length Survey

Consent Form

EXPLANATION OF RESEARCH

Project Title: Defining "intuitive use" Survey
Principal Investigator: Kenneth H. Funk II, PhD
Student Researcher: Tylee M. Cairns
Co-Investigator(s): None
Sponsor: None
Version Date: 04/16/2015

Purpose: You are being asked to take part in a research study. The purpose of this research study is to understand how individuals define the word "intuitive" and uncover other factors that are associated with its use.

Activities: The study activities include completing a web-based survey. The survey will ask you open-ended questions and your level of agreement with statements.

Time: Your participation in this study will last about 10 minutes.

Risks: There are no foreseeable risks associated with this study.

Benefit: We do not know if you will benefit from being in this study. However, it is assumed that understanding users' definition of "intuitive use" will allow designers to create products that are more intuitive for users. This may result in a potential long-term benefit for society.

Payment: You will not be paid for being in this research study.

Confidentiality: Your participation in this study is anonymous.

Voluntary: Participation in this study is voluntary. You MUST be over 18 years of age.

Study contacts: If you have any questions about this research project, please contact: Kenneth H. Funk II, PhD (funkk@engr.orst.edu). If you have questions about your rights or welfare as a participant, please contact the Oregon State University Institutional Review Board (IRB) Office, at (541) 737-8008 or by email at IRB@oregonstate.edu

Demographics

Demographics

Age (years)

- ○ 18-25
- ○ 26-34
- ○ 35-54
- ○ 55-64
- ○ 65 or over

Gender

- ○ Male
- ○ Female
- ○ Other (please specify): ____________

What is the highest level of education you have completed?

- ○ Less than High School
- ○ High School / GED

- ○ Some College
- ○ 2-year College Degree
- ○ 4-year College Degree
- ○ Masters Degree
- ○ Doctoral Degree
- ○ Professional Degree (JD, MD)
- ○ Other ________

A past or current job contained these duties. Mark all that apply.

- ☐ Design of Products
- ☐ Design of User Interfaces
- ☐ Human Factor/User Interface Requirements Development
- ☐ Human Factors
- ☐ Ergonomics
- ☐ Human-Computer Interaction
- ☐ User Experience
- ☐ Usability
- ☐ None of the above

How often do you use a microwave oven?

- ○ Daily
- ○ Weekly
- ○ Monthly
- ○ Yearly
- ○ Never

What is your country of permanent residence?

Scenario

Scenario

Sarah just received a new microwave oven as a gift to replace her old one, which she owned for several years. That evening she unboxed the new microwave for the first time and reheated her food. Afterward, she called her friend to tell her "My new microwave is very **intuitive** to use."

What do you think Sarah means when she uses the word **intuitive**? That is, what do you think Sarah's definition of **intuitive** is?

What words or phrases do you think are roughly synonymous with (have about the same meaning as) **intuitive**?
(Example: Word 1, Word 2, Phrase 1, Phase 2, etc.)

Statements

Statements

Please indicate your level of agreement for each statement with respect to Sarah's statement "My new microwave is very **intuitive** to use."

Sarah said her new microwave was intuitive to use because she could use it **subconsciously**.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Sarah said her new microwave was intuitive to use because she **made errors** when using it.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Sarah said her new microwave was intuitive to use because she could use **prior knowledge** from her old microwave.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Sarah said her new microwave was intuitive to use because she **thought deeply** about how to make it do what she wanted.

Strongly

Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Sarah said her new microwave was intuitive to use because it was **satisfying** to operate.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Attributes

Attributes

Sarah made the statement, “My new microwave is very **intuitive** to use.” Please indicate your level of agreement with each statement below.

Sarah’s new microwave can be intuitive to use regardless of the **physical effort** it takes to operate.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Sarah’s new microwave can be intuitive to use regardless of the **time** it takes to operate.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Sarah’s new microwave can be intuitive to use regardless of its **cost ($).**

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
○	○	○	○	○	○

Experimental Attributes

The following affect how intuitive Sarah's microwave is to use.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
Sarah's Mood	○	○	○	○	○	○
Physical Size	○	○	○	○	○	○
Safety	○	○	○	○	○	○
Similarity to her previous microwave	○	○	○	○	○	○
Aesthetics	○	○	○	○	○	○
Level of Complexity	○	○	○	○	○	○

Experimental Attributes Explaination

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "${q://QID37/ChoiceGroup/SelectedAnswers/1}" about **Safety**. Please provide an explanation below.

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "${q://QID37/ChoiceGroup/SelectedAnswers/2}" about **Aesthetics**. Please provide an explanation below.

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "${q://QID37/ChoiceGroup/SelectedAnswers/3}" about **Level of Complexity**. Please provide an explanation below.

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "${q://QID37/ChoiceGroup/SelectedAnswers/4}" about **Physical Size**. Please provide an explanation below.

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "${q://QID37/ChoiceGroup/SelectedAnswers/5}" about **Sarah's Mood**. Please provide an explanation below.

In the previous question "The following affect how intuitive Sarah's microwave is to use." you indicated "${q://QID37/ChoiceGroup/SelectedAnswers/6}" about **Similarity of her previous microwave**. Please provide an explanation below.

Appendix C – Institutional Review Board (IRB) Approval and Recruitment Documents

IRB Exempt Notification

Institutional Review Board
Office of Research Integrity | Oregon State University
B308 Kerr Administration Building, Corvallis, OR 97331-2140
Telephone (541) 737-8008
irb@oregonstate.edu | http://research.oregonstate.edu/irb

EXEMPT DETERMINATION

Date of Notification	04/16/2015		
Study ID	6804		
Study Title	Defining "intuitive use" Survey		
Principal Investigator	Kenneth Funk		
Study Team Members	Tylee Cairns		
Submission Type	Initial Application	Date Acknowledged	04/16/2015
Level	Exempt	Category(ies)	2
Funding Source	None	Proposal #	N/A
PI on Grant or Contract	N/A	Cayuse #	N/A

The above referenced study was reviewed by the OSU Institutional Review Board (IRB) and determined to be exempt from full board review.

EXPIRATION DATE: 04/15/2020
*The exemption is valid for **5 years** from the date of approval.*

Annual renewals are not required. If the research extends beyond the expiration date, the Investigator must request a new exemption. Investigators should submit a final report to the IRB if the project is completed prior to the 5 year term.

Documents included in this review:

- ☒ Protocol
- ☒ Consent forms
- ☐ Assent forms
- ☐ Alternative consent
- ☐ Letters of support
- ☒ Recruiting tools
- ☒ Test instruments
- ☐ Attachment A: Radiation
- ☐ Alternative assent
- ☐ Grant/contract
- ☐ External IRB approvals
- ☐ Translated documents
- ☐ Attachment B: Human materials
- ☐ Other:

Comments:

Principal Investigator responsibilities:

- Certain amendments to this study must be submitted to the IRB for review prior to initiating the change. These amendments may include, but are not limited to, changes in funding, , study population, study instruments, consent documents, recruitment material, sites of research, etc. For more information about the types of changes that require submission of a project revision to the IRB, please see: http://oregonstate.edu/research/irb/sites/default/files/website_guidancedocuments.pdf
- All study team members should be kept informed of the status of the research. The Principal Investigator is responsible for ensuring that all study team members have completed the online ethics training requirement, even if they do not need to be added to the study team via project revision.
- Reports of unanticipated problems involving risks to participants or others must be submitted to the IRB within three calendar days.
- The Principal Investigator is required to securely store all study related documents on the OSU campus for a minimum of seven years post study termination.

Recruitment Messages

OSU Oregon State University

Recruitment Email for Research Study:
Defining "Intuitive Use" Survey

Letters / fliers template:

Participants needed to complete a survey for a research project.

Study title: Defining "Intuitive Use" Survey

Principal Investigator: Kenneth H. Funk II, PhD

Student Researcher: Tylee M. Cairns

To participate in the survey: Click Here

For more information about this study, please contact:
Tylee M. Cairns by phone at 503-806-3038 or e-mail at cairnst@onid.oregonstate.edu
Or
Kenneth H. Funk II, PhD, by phone at 541-737-2357 or email at funk@engr.orst.edu.

Thank you,

Kenneth H. Funk II, PhD

Participants will not be compensated for their participation.

Verbal recruitment guide:

The recruiter will verbally mention all the following:

- Title of the study
- Purpose of the study
- PI of the study
- Required skills/experience to participate
- Expected duration
- Rewards
- How to enroll to the study or follow up to indicate interest.

Social media posts:

Post 1

What is an **intuitive** product? Participate in a research survey to share your opinion. **link***

Version: 09/04/2013

Recruitment Email for Research Study:
Defining "Intuitive Use" Survey

<u>**Post 2**</u>

What makes an interface **intuitive**? Fill out this research survey to share your opinion. **link***

<u>**Post 3**</u>

Are you involved with product design, human factors, usability, or UX? We are interested in having you participate in a research survey about **intuitive use**! ***link*** *

link ** will take participants to the online Qualtrics survey which contains the consent form as the first page.*

<u>**Email:**</u>

Option 1:
Hello [individuals name],

[Summary of our last encounter or how I know the individual.] I hope you are doing well! I am currently conducting a survey for my thesis research. The recruitment information and link to the survey are listed below. Please feel free to forward this survey to your colleagues. I appreciate your help!

Example:
Hello Meagan,

We met through the College of Engineering and I helped film the majors' video at Xerox for the Oregon Stater. I hope you are doing well! I am currently conducting a survey for my thesis research. The recruitment information and link to the survey are listed below. Please feel free to forward this survey to your colleagues. I appreciate your help!

Option 2:
Hello [individuals name],

[Summary of how I received their contact info and how I am connected to the contact they know.] I am conducting a survey on "intuitive use" for my thesis research. [Explain why I think they would be interested in this research.] The recruitment information and link to the survey are listed below. Please feel free to forward this survey to your colleagues. I appreciate your help!

Example:
Hello Will,

I received your contact information via Dr. Funk at Oregon State University. I am his graduate student working on my Masters. I am conducting a survey on "intuitive use" for my thesis research. I think you would be interested in this research because it relates to your field of User Experience. The recruitment information and link to the survey are listed below. Please feel free to forward this

Recruitment Email for Research Study:
Defining "Intuitive Use" Survey

survey to your colleagues. I appreciate your help!

The Oregon State University School of Mechanical, Industrial and Manufacturing Engineering is **conducting research on the terms "intuitive use"**. We are seeking participants who are at least 18 years old to **complete a survey**. The purpose of this study is to better understand how users and designers define the word intuitive with regards to products and interfaces. "This product is intuitive to use". What does that really mean? This study hopes to better understand the meaning behind the terms "intuitive use" to help designers produce better products and interfaces.

Participation in this study involves:

- A time commitment of 10 minutes
- Completing an online survey

SURVEY LINK: [link here]

Thank you,

Kenneth H. Funk II, PhD
Principle Investigator

Study Title: Defining "Intuitive Use" Survey

Recruitment Flyer

Appendix D - Open-ended Attribute Tables

Coded attributes for participants' open-ended response to the question, "What do you think Sarah means when she uses the word **intuitive**? That is, what do you think Sarah's definition of **intuitive** is?

		Group					
#	Attribute	User (Count)	User (%)	Designer (Count)	Designer (%)	Total (Count)	Total (%)
1	Easy, Easy to use/understand/learn	20	58.8%	51	61.4%	71	60.7%
2	No instruction/manual needed	16	47.1%	26	31.3%	42	35.9%
3	Reference to buttons, controls, interface, or functions	8	23.5%	22	26.5%	30	25.6%
4	Use was correct, successful, effective, met her goal or did what she wanted	4	11.8%	18	21.7%	22	18.8%
5	Use of past experience/expectations	3	8.8%	15	18.1%	18	15.4%
6	Use was logical or makes sense	8	23.5%	9	10.8%	17	14.5%
7	Requires no learning/training	3	8.8%	8	9.6%	11	9.4%
8	Similar or familiar	3	8.8%	7	8.4%	10	8.5%
9	Simple	1	2.9%	9	10.8%	10	8.5%
10	Use was quickly or automatic	1	2.9%	8	9.6%	9	7.7%
11	User friendly	2	5.9%	5	6.0%	7	6.0%
12	Works the first time/try	2	5.9%	5	6.0%	7	6.0%
13	No explanation necessary or self-explanatory	0	0.0%	6	7.2%	6	5.1%
14	No thought is needed	1	2.9%	5	6.0%	6	5.1%
15	Matches her mental model	0	0.0%	5	6.0%	5	4.3%
16	Straight forward in operation	0	0.0%	2	2.4%	2	1.7%
17	Instinctive	1	2.9%	1	1.2%	2	1.7%
18	Obvious	1	2.9%	1	1.2%	2	1.7%
19	Convenient	0	0.0%	1	1.2%	1	0.9%
20	Use was confident	0	0.0%	1	1.2%	1	0.9%
21	Use was natural	0	0.0%	1	1.2%	1	0.9%
22	Helpful	1	2.9%	0	0.0%	1	0.9%

Coded attributes for participants' open-ended response to the question, "What words or phrases do you think are roughly synonymous with (have about the same meaning as) **intuitive**? (Example: Word 1, Word 2, Phrase 1, Phase 2, etc.)"

	Group					
Attribute	Users (Count)	Users (%)	Designers (Count)	Designers (%)	Total (Count)	Total (%)
Easy to use/understand/figure out	3	57.6%	11	63.9%	14	62.1%
Understandable, make sense, logical	19	42.4%	53	27.7%	72	31.9%
Simple	14	9.1%	23	24.1%	37	19.8%
Instinctual/inherent/innate	3	18.2%	20	10.8%	23	12.9%
Natural	1	21.2%	10	9.6%	11	12.9%
User friendly	4	9.1%	7	13.3%	11	12.1%
Anticipate outcomes or work as expected	0	9.1%	1	12.0%	1	11.2%
Obvious	1	12.1%	2	10.8%	3	11.2%
Clear	0	3.0%	1	12.0%	1	9.5%
Straight forward	0	12.1%	1	8.4%	1	9.5%
Common/basic sense/knowledge	3	9.1%	10	8.4%	13	8.6%
Self-explanatory	0	6.1%	1	9.6%	1	8.6%
No instruction/direction needed	1	3.0%	0	7.2%	1	6.0%
Prior knowledge/previous experience	3	3.0%	7	6.0%	10	5.2%
No learning/training	6	3.0%	9	6.0%	15	5.2%
Smart/intelligent	4	3.0%	9	4.8%	13	4.3%
Fast/quick	7	3.0%	8	3.6%	15	3.4%
Familiar	2	0.0%	8	4.8%	10	3.4%
Similar	1	6.1%	4	2.4%	5	3.4%
Takes little thought	0	3.0%	1	3.6%	1	3.4%
Feeling or feeling of knowing	1	3.0%	6	2.4%	7	2.6%
Clear interface	1	3.0%	1	1.2%	2	1.7%
Recognized	0	0.0%	1	2.4%	1	1.7%
Innovative/new and exciting	1	3.0%	3	1.2%	4	1.7%
Mental model	0	0.0%	1	2.4%	1	1.7%
Consistency	0	0.0%	1	2.4%	1	1.7%

	Group					
Attribute	Users (Count)	Users (%)	Designers (Count)	Designers (%)	Total (Count)	Total (%)
Second nature	0	0.0%	2	2.4%	2	1.7%
Easily identifiable	1	0.0%	5	2.4%	6	1.7%
Hunch	1	0.0%	1	1.2%	2	0.9%
Not based on logic or reasoning	0	0.0%	2	1.2%	2	0.9%
Seeing to future	0	0.0%	1	1.2%	1	0.9%
Technology	0	0.0%	2	1.2%	2	0.9%
Wisdom	1	3.0%	5	0.0%	6	0.9%
Automatic	0	0.0%	4	1.2%	4	0.9%
Guided	2	0.0%	2	1.2%	4	0.9%
Resourceful	0	0.0%	2	1.2%	2	0.9%
Confidence	2	0.0%	3	1.2%	5	0.9%
Usable	0	0.0%	1	1.2%	1	0.9%
Not intimidating	0	0.0%	1	1.2%	1	0.9%
Visual	0	0.0%	1	1.2%	1	0.9%
Sleek design	0	0.0%	1	1.2%	1	0.9%
Easy navigation	1	0.0%	0	1.2%	1	0.9%
Native	0	3.0%	1	0.0%	1	0.9%
Chronological	0	0.0%	1	1.2%	1	0.9%
Conventional	0	0.0%	1	1.2%	1	0.9%
Typical	0	0.0%	1	1.2%	1	0.9%
Interactive design	0	0.0%	2	1.2%	2	0.9%
Efficient	0	0.0%	1	1.2%	1	0.9%
Accessible	0	0.0%	1	1.2%	1	0.9%
Convenient	0	0.0%	1	1.2%	1	0.9%